Handbook for Motion Picture and Stereopticon Operators

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HANDBOOK

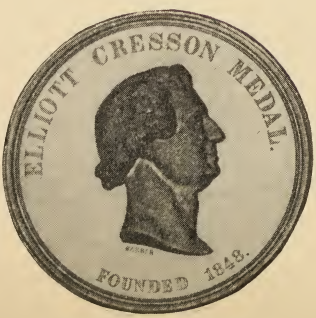
FOR

MOTION PICTURE

AND

STEREOPTICON

OPERATORS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for his
Phantoscope,
1898.

HANDBOOK

FOR

MOTION PICTURE

AND

STEREOPTICON

OPERATORS

BY

C. FRANCIS JENKINS
MEDALIST FRANKLIN INST.

OSCAR B. DEPUE
WITH BURTON HOLMES

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PREFACE.

This book, as its name implies, is intended as a text-book or book of reference in the several branches of the motion-picture art, from the perforation of the film through the operations of photographing, developing, printing, and projecting these pictures, alone and in connection with lantern projection of still pictures.

The work is conscientiously written, embodies the experience of the writers covering the entire period since the adoption of flexible film as a picture carrier, and also the details of interest picked up all over the world in the many trips which have been made in collecting pictures for the Burton Holmes "Travelogues."

It is believed to be as complete as the art at present permits, containing, as it does, the best-known practice in all its branches by the most skilful workers in the art everywhere, and is published in the hope that it may hasten a still further improvement in the quality of the pictures, and the better appreciation of the great value of these pictures in scientific work and the recording of national and historical events in a far more natural and accurate manner than posed still pictures permit.

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INTRODUCTION.

Chronophotography.

"Motion Pictures," as commercially employed for the entertainment of large audiences, consists of an analytical process by which a photographic record is made of the scene it is desired to preserve, and a synthetical assembling of these separate photographs into a more or less exact counterfeit of the original movement. The favorite method of analysis is the making of pictures one above another on a long strip of sensitive film. The synthesis is accomplished by projecting these pictures one after another upon a screen by means of an optical lantern. The projection of the little pictures succeed each other so rapidly that the human eye is unable to separately distinguish them, and the effect is that of a simple picture containing animated subjects.

Like all notable achievements in mechanisms, animated picture machines had a long line of predecessors, and the difficult problem of recording and reproducing motion did not yield without much preliminary fumbling. Hosts of eminent scientists and practical men have worked upon the problem, and the precipitate of knowledge from

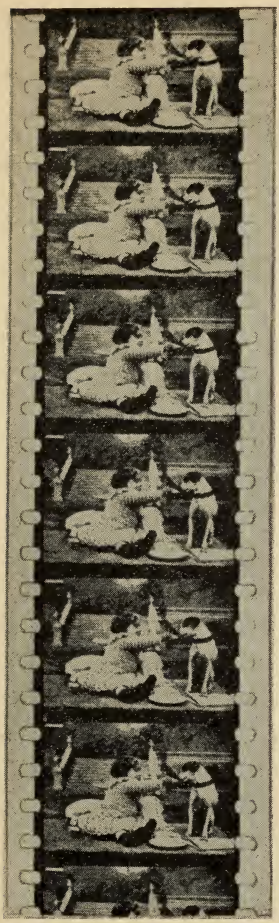
thousands of experiments has afforded a harvest of interesting results and rendered the final accomplishment possible.

The Usual Method.

The generally-adopted method consists in making on a long ribbon of pellicular fabric a series of consecutive photographs representing all the constantly-changing phases of action of a scene. The camera in which these photographs are made consists of a casing or box with lens and shutter and a mechanism for rapidly shifting the sensitive surface in the focus of the lens. This roll of sensitive film is unwound past the lens, exposed, and afterward rolled again.

After development a positive or transparency is printed therefrom, the roll subsequently being placed in the projecting lantern. This lantern is fitted with practically the same mechanism used in the camera for unwinding the film, passing it behind the projecting lens and winding it again, all in such manner as to give upon the screen a single enlarged picture of the scene photographed, and with all the action of the original in a continuous and harmonious reproduction of singular fidelity.

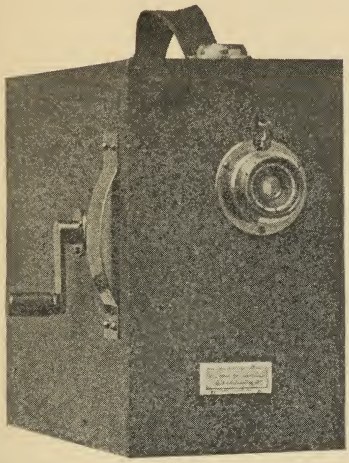
The entire process is attended with little difficulty and is exactly like ordinary photographic processes, although special mechanism is required to handle the long strips of picture-carrying rib-



bon. The film is of transparent celluloid, one side of which is coated with a sensitive emulsion, that of the negative being much more rapid than the positive stock, although the latter produces better results for the lantern ribbons.

The little pictures are not quite so wide as the film, leaving a narrow unoccupied marginal edge, in which are punched the little holes by which the film is kept in register during each step of the entire process. The pictures are $\frac{3}{4}$ of an inch in height by 1 inch wide, the latter dimension being across the film between the perforations, and are placed one immediately above another, giving sixteen pictures to each foot of film.

The standard ribbon is $1\frac{3}{8}$ inch wide and about $\frac{5}{1000}$ inch thick and in lengths approximately 200 feet to each roll in America; and about 50 meters in Europe. The manufacturers furnish films, either perforated or unperforated, as desired. The roll when received from the manufacturers is covered with tinfoil and black paper, and encased in a tin box, sealed against the air.



PHOTOGRAPHING.

The Camera.

The camera is equipped with a photographic lens of large aperture and short focus, so that it will work with a quick exposure. The casing or box contains suitable mechanism for guiding and feeding the film step by step in the focus of the lens, and a rotary shutter with one or more radial slits therein so arranged that the lens is uncovered only when the film is momentarily arrested, the latter being pulled down quickly between exposures so as to present a fresh surface each time. From

fifteen to twenty pictures are made per second, according to preference or necessity, the exposure depending entirely upon the strength of light, rapidity of movement of the object photographed, and the result desired to be attained.

A Professional Camera.

A professional camera should have embodied in its construction the following features: A set of two or more interchanging lenses of different foci; a rising and falling front; a perfectly-balanced shutter (close to the film), the opening in which can be increased or diminished while the machine is in motion, to compensate for varying speed of the taking, where the exigencies of the subject make it desirable; detachable light-tight film boxes; indicator showing amount of film remaining unused at any moment; a level and a finder, a folding main crank, and an auxiliary folding trick-picture crank on a part of the mechanism which makes but one picture each revolution of the crank; a tripod having a permanently-fixed panorama head, and stiff telescoping non-folding legs. If intended for travel use, the camera should be inclosed in a leather carrying case. The lens when all the way back should be in universal focus. There should be a tripod nut in the top of the camera to make reversed pictures directly in the camera.

Masks.

Some of the best cameras are also fitted with little thin metal masks slipped in immediately in front of the film window to give their peculiar shape to the resultant picture. These metal masks are made in various forms, namely, diamond-shaped, moon-shaped, heart-shaped, oval, double oval, etc. The window in cameras should be just a little smaller than the film movement so as to leave a very narrow clear line between the pictures when developed. This is of the greatest aid in projecting.

Tinters, or Ray Filters.

It will be found extremely convenient, especially in professional cameras, if a ray filter can be located in the lens holder, immediately behind the lens; and the very best filter is one in which the tint gradually increases in strength from one edge to the opposite, admirably compensating for the difference in the actinic quality of the sky and the foreground.

Static Fogging.

One of the worst troubles the motion-picture photographer has to contend with is static fogging. That is, electricity generated as the film is drawn through the velvet lining usually employed to render the opening in the film box light tight. The static charge on the film jumps off to the first

piece of metal it passes and these electric flashes fog the film. This is a serious trouble, very difficult to guard against, and is especially troublesome in winter on a crisp dry day. The means usually employed to counteract this is to create a moist atmosphere in the camera. To provide means for taking off this static charge quietly, that is, without sparking, is the plan which suggests itself to most effectually eliminate the trouble. Another effective device is a film exit in the film magazines which is usually closed light tight but which when the magazine is in place is opened automatically by the closing of the camera door.

Setting Up.

Arriving at the desired location, the camera is set up and focused, the legs well spread out to give stability. The film is then drawn from the top box, led down through the mechanism, and attached to the spool in the receiving box below. Leave a loop above the window.

If the lens is not of universal focus, the best focus is secured by putting in a piece of matt surface film between the tension members to receive the image. After focusing this is removed. The same care should be exercised in focusing, leveling, the use of the finder, etc., as though an ordinary camera were used. Stops in the lens should be

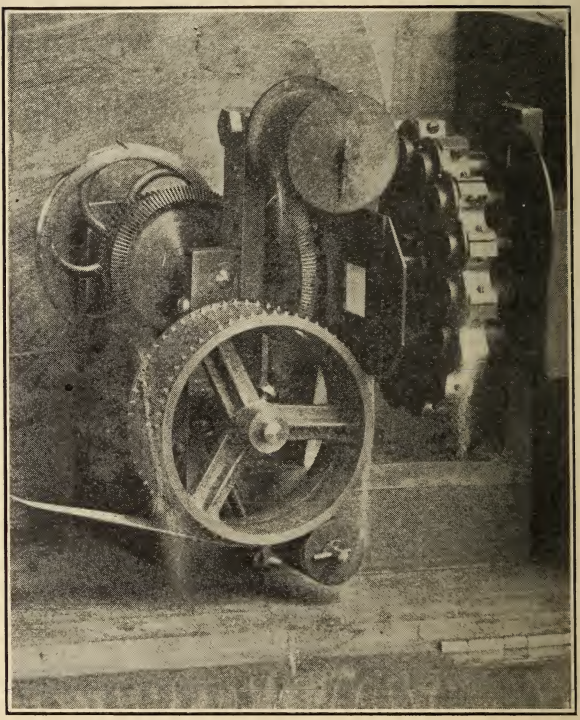
chosen according to the intensity of the light and size of the opening in the shutter to the speed of the latter, which can be determined accurately only by experiment. Everything being ready, the camera is turned uniformly until the whole of the film has been wound out of the top box into the receiving box, or until the scene is completed.

Reloading.

The now empty box on top replaces the receiving box, which latter is marked "Exposed" and put into the carrying case. A box of unexposed film is again put in the camera and everything is ready for another exposure.

It must be understood that the film which is pulled out of the top box, to be threaded through the camera, is not wasted, for to the end of the unexposed sensitive film is spliced, in the darkroom, a piece of film, say, 5 feet long, to protect it from the light and facilitate the threading of the camera. Old, spoiled film will answer, of course.

In photographing any scene or subject one of the main things to guard against is the passing of extraneous objects into or across the field of the lens very close to the camera, thus obliterating the entire view for the time being. Some one ought always to be suitably stationed to see that this does not happen.



ROTARY LENS CAMERA.

Jenkins' Rotary Lens Camera.

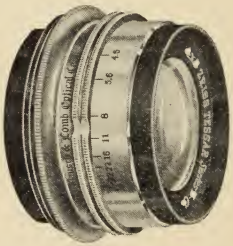
The advantages of a constantly-moving film are very manifest. If pictures could be photographed upon a moving negative, it would make a flexible instrument, one capable of making a very great number of pictures per second. Thus: If the light from the object being photographed is caused to travel downward at the same speed as the film, that is, so that it shall not (until cut off entirely) depart from the position it occupied when it first impinged upon the film, the result will be a sharp, properly-exposed picture. A camera designed and constructed in which lenses of the same focus are caused to rotate about a common axis gives superior results at very high speeds, permitting the photographing of objects in too rapid motion for the ordinary motion-picture camera. By means of proper gears, etc., the film is caused to travel at the back of the camera in the same direction and in exact synchronism with the motion of the lenses. As each lens passes an opening in the front of the box it transmits momentary images to the moving sensitive film, and as the film is constantly wound upon the drum each picture is taken in a new place upon the film. The lenses travel in an arc of a circle, to be sure, but the opening is so small, as compared with the lens circle, and the arc so nearly coincides with a straight line that this feature is not detrimental, neither is the fact

that the negative and the lenses are at slightly different distances from the subject. The result of continued operation is a length of negative film with similar pictures thereon, each picture differing slightly from the preceding one owing to the constant movement of the object photographed.

Two hundred and fifty pictures per second have been made in this camera and there is no limit to the speed, except illumination and sensitiveness of film.

Lenses.

The choice of a lens for a camera should be governed by the focal length, together with the rapidity and depth of focus, it being understood,



of course, that the lens is free from astigmatism and from chromatic and spherical aberration. The shorter the back focus the greater the depth of focus; and the larger the proportion of the aperture to the equivalent focus the greater the rapidity.

Stops.

Most photographic lenses are marked in "*f*" numbers, on what is known as the "U. S." system, that is, the aperture is expressed as a fraction of the equivalent focus. Now with a given lens a stop with an aperture of twice another has an opening four times the area, admitting four times the light, so that the exposure for the latter would be four times that through the former to get the same exposure. The converse is also true, that a negative twice as far from a given aperture requires four times the exposure, because the light on the plate or film in the second position is spread over four times the surface in the first position. A lens of 4-inch equivalent focus and with diaphragm stops having openings of $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, and $\frac{1}{16}$ inch would have the stops marked *f*-8, *f*-16, *f*-32, *f*-64, respectively, each being that fraction of the equivalent focus of the 4-inch lens to which they belong. However, makers usually mark stops between these so that each requires but twice the exposure of the one next larger. It will thus be seen that a ready means of judging of the working speed of different lenses is available, for a comparison of the "*f*" numbers gives the desired information. Some makers, however, have adopted a system of numbering which gives only the comparative exposures for the stops of that particular

lens, each requiring twice the exposure for the next larger, thus, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{32}$, etc.

The Light.

In order to more surely get a proper exposure at all times, it is well to remember that: a seascape requires the quickest exposure; that an open landscape requires about three times as long; that foreground, nearby objects, buildings, etc., about six times; portraits inside under good light about one hundred times; that the light in June is about four times as effective as it is in December; that the light from 10 a. m. to 2 p. m. is more than twice as actinic as it is from 4 to 6 o'clock; that the speed of the shutter must be quickened inversely as the distance to the object photographed, the latter having a given movement; and that a large lens is not more rapid than a small one if the proportion of diaphragm to focus remains unchanged.

Tele-Photo Lenses.

Some interesting results have been achieved in moving pictures using tele-photo lenses. The method is not recommended except where it is impossible to obtain the same result in the ordinary manner.

DEVELOPMENT.

Developing Machines.

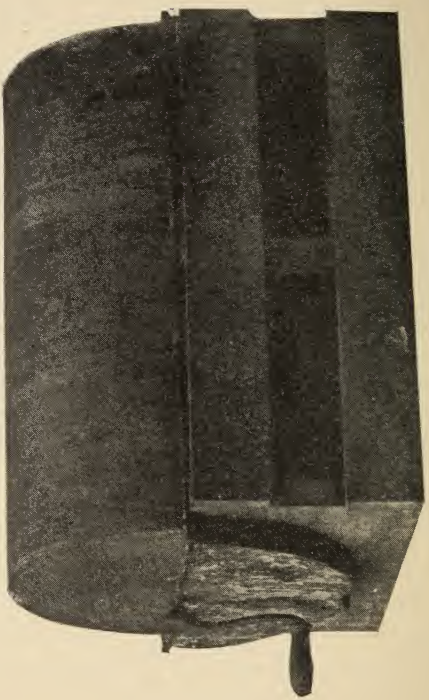
Having exposed the film in the camera, the next step is development. To develop this strip, carrying on its gelatine surface some 1600 latent images every 100 feet, is worthy the effort of the most patient photographer, for each picture must have the same density, remain without stain throughout, and must be handled so as not to be abraided in any part of its length.

Drum Method.

The method most in use consists in winding the film spirally while dry upon a large drum, the latter supported free to rotate in a semicylindrical tray into which the developing fluid is poured. These drums are usually 3 feet or more in diameter and 6 feet or more in length, and driven by a motor, although a crank may, of course, be used. A drum 2 feet in diameter and 2 feet long holds 100 feet of film laid close.

Pin Cross-Arms.

No developing device is, however, so suitable for travel (and many operators prefer it at home) as a pair of brass cross-bars having vertical pins



DRUM DEVELOPER.

driven tightly therein, and known as the "pin-tray" method. Around these pins the film is wrapped in concentric spirals. The whole is then set down in the tray and treated much as a large

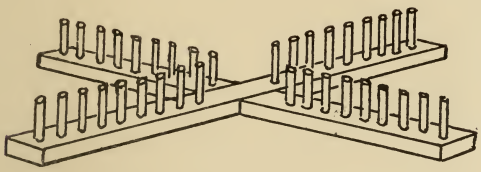


plate would be. The three trays, *i. e.*, developing, washing, and fixing, should all be made so that they will nest. A tray 20 inches square, with pins located half an inch apart in 18-inch cross-arms, will hold a hundred feet of film.

Daylight Tank.

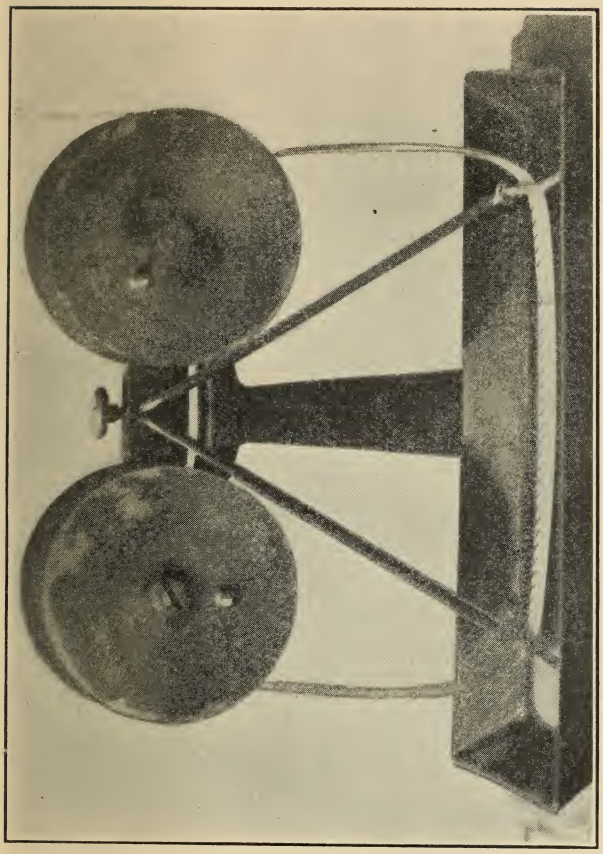
A daylight developing machine consists of a light-tight box a little wider than the film, having a small spool in the center on which is wound a long piece of celluloid having fastened along its edges narrow strips of laterally corrugated rubber, the distance between the corrugated strips being enough to admit the standard film. This strip is pulled out and a hundred-foot film attached close to the roll and the two are wound together around the spool in the box. The solution is then poured in. The crank is turned until the development is complete.

Double-Spool Method.

Another device for developing these long lengths of film consists of a frame supporting two flanged spools above a long narrow tray. One end of the film is attached to one of the spools, upon which it is wound, and then passed, gelatine side down, through the fluid, being held therein by small rollers at each end of the tray and the other end of the film fastened to the other spool. The film after saturation is wound from one spool to the other through the solution again and again until full detail and proper density is secured, which can be determined by picking up the slack of the film and examining it before a conveniently-located non-actinic light. The trays are readily removed, without disturbing the spools holding the film, and the washing, fixing, hardening, soaking, etc., can therefore be quickly and conveniently done.

Test Strips.

In determining the development nothing is better than developing small test strips, timing and treating the development of the full-length strip to correspond with the test strip. Generally, the development should be continued until the face of the film is more or less shadowed over and the image well silhouetted on the back. The developing frame is then lifted out and set in the washing water for two or three minutes, and then put



TWO-SPOOL DEVELOPER.

in the fixing bath. The fixing should, as a rule, be continued as long again as it takes to make the image disappear. The film should then be thoroughly washed. An acid fixing bath with sufficient sulphite to keep the film clear is best, with alum to give it hardness.

Washing and Hardening.

To wash 25 minutes in rapidly-changing water is usually long enough, after which the film should be given a glycerine bath of five minutes (see formulæ in back of book). If no cold water can be obtained, give the film a preliminary bath in alum or formaldehyde solution before developing; one ounce of formaline to 60 ounces of water.

Developers.

The standard pyro developer is in favor with many operators; but for traveling, the metol-hydro developer is one of the most desirable. It keeps well, and a great number of films can be developed therein. Rodinol is another good developer—a single solution developer. The metol bicarbonate formulæ to be found in the back of this book is especially good for developing under-exposed film as it will not fog in an hour's development.

Drying Rack.

After thoroughly washing, fixing, and final washing, the film is carefully reeled upon a revolv-

ing rack and hung up, in a draft of air, preferably, to dry. In all the operations care should be exercised to see that the gelatine is not skinned or knocked off.

Temperature.

The temperature of the dark-room should be maintained at about 65° Fahrenheit, and the developer, when poured into the tray, should not be too cold in winter or too warm in summer. Do not develop in ice water and then wash in warm water.

The best temperature for all around work is 65°.

The Chemicals.

Two chemical compounds enter into the matter of development, the developer (pyro, for instance) and the accelerator (an alkali). For a normal exposure a certain given amount of each diluted with a certain amount of water produces the best result. An excess of developer will give hard contrasts, although advantageous to use for an overexposure; while an excess of alkali gives more softness and detail in the shadows and is therefore advantageous for an underexposure. Giving the film a preliminary bath in an alkali before development is sometimes resorted to for an underexposure, while the use of old solution retards development and is recommended for overexposures. An excess of water also checks development and

consequently insures more strength in underexposure. For a normal exposure more water gives softness and less water contrast.

Sulphite of soda in developers is used to prevent oxidization and discoloration. Anhydrous sulphite is twice the strength of crystals.

Bromide is added to developers to restrain development in the shadows, producing contrast.

In dissolving chemicals put powders in the graduate dry and then add water very slowly, stirring with glass rod or strip. This will prevent the formation of hard, almost insoluble lumps, and the dissolving of the chemicals is much sooner complete.

Judging Negatives.

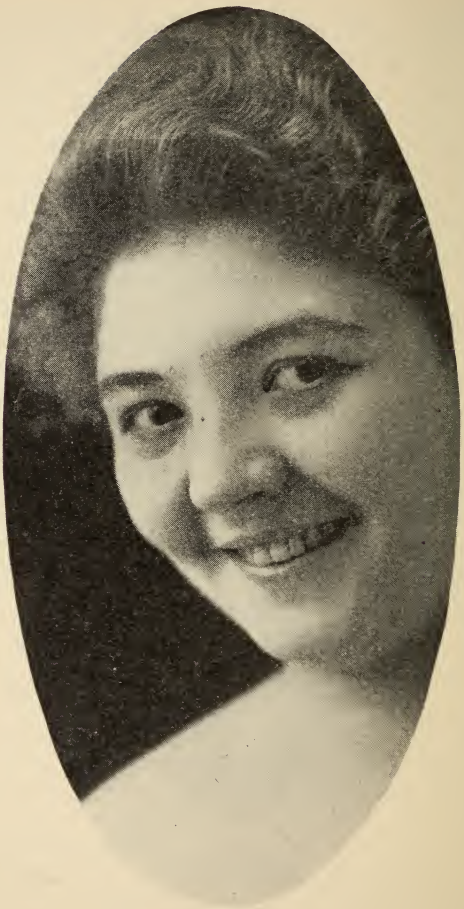
In endeavoring to judge of the cause of bad negatives it is well to remember that a weak negative with clear shadows indicates underdevelopment, while strong high lights with clear shadows means underexposure. Density with plenty of detail in the shadows means overexposure, and "flatness" overexposure and underdevelopment.

In motion-picture films, develop for details as excess density can always be taken care of by after-treatment (see formulas).

Dark-Room Illuminant.

Daylight for a dark-room illuminant is not recommended, artificial light being more uniform.

The combination of green and orange glass is soft and pleasant to the eyes and excellent for examining film. In order to be assured that one's light is safe, it is well to test it. Expose half of a short piece of film before the dark-room light for, say, one minute, keeping the other half protected. If development leaves half of the film clear and the other half cloudy the light is not safe. A sheet or two of postoffice paper, a reddish-yellow paper, will probably correct it.



PRINTING.

Constant Feed.

The printing of the positive or transparency is the next step. The negatives, until wanted, are kept rolled up and stored in a case fitted with shallow drawers, often in fire-proof storage, and sometimes insured as an additional precaution.

The printer is generally so constructed that the negative and sensitive unexposed positive are drawn along past a narrow opening beneath the light, exact registration being secured by having the teeth of the feeding sprocket project through both, although some operators employ a machine having two sprockets, one to feed the negative and the other to feed the unexposed film.

Portable Printer.

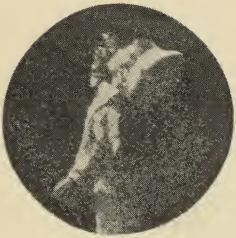
A portable printer giving good results, consists of a narrow box, in the center of which a sprocket is located, free to rotate by means of a worm and gear, turned by hand, or driven by any suitable motive power. There is a narrow opening in the lid of the box so located that when the lid is closed the opening therein comes immediately over the center of the sprocket. In use the negative and the unexposed sensitive film are dropped into the

end of the box, and both held down upon the sprocket teeth, the negative of course on top, gelatine surfaces in contact. The lid is shut down, the box placed beneath a suitable light, and the sprocket rotated. The novelty of the device is that the films move continuously under a uniform source of light without intermittent motion or the use of shutters. The two films are drawn beneath the light together, the exposure is regulated by increasing or decreasing the opening in the lid of the box or by placing the printer nearer or farther from the light.

Imperfect Registration.

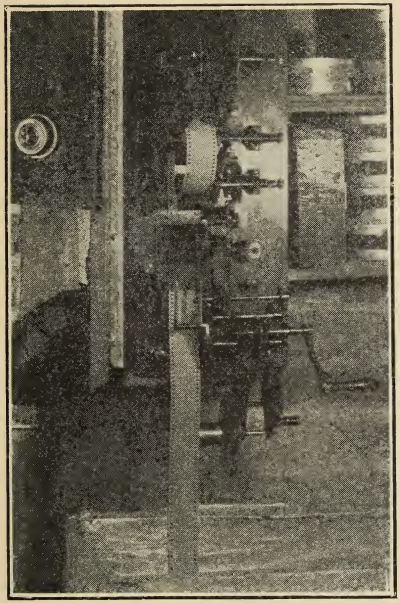
A trouble which causes more annoyance than any other is imperfect registration of the pictures in the camera from faulty construction, either in the camera or printer.

It will readily be understood that if the film is not advanced exactly the same distance before each exposure—and it is readily discovered (when too late, however) by observing that the little lines of separation between the pictures are not all alike (sometimes white, sometimes black)—no after process can correct the error so as to secure steady pictures when projected upon the screen. But, given a perfect negative, the battle is more than half won, for if the perforations are correct good positives ought to be secured.



A Cabinet Printer.

A professional printing machine is similar to a camera fastened to a wall, that is a wall cabinet, at the right height so that the operator can be seated on a stool and look at the image seen through the positive film, with a ruby glass cover to prevent the escape of light into the room. Thus the density can be watched and the speed can be changed accordingly, or the light moved back or forward. This arrangement also permits of the rapid and proper framing of the picture, just as in projection. The film should run down loosely into a tight receptacle below, a box or lined basket. There should be a feed-out sprocket for the negative and one for the positive, to feed out a little loop above the window, the same as in a projecting machine, in order to make the work of the feed mechanism as light as possible, insure perfect registration, and prevent damage to the holes in the film. The ordinary incandescent lamp is suitable, a 16- or 32-candlepower, according to the density, located from 3 inches to 1 foot distant from the negative. A piece of ground glass is arranged in front of the window for diffusion. Some operators use two or three thicknesses of ground glass so that one, two, or three thicknesses may be used according as the density of the negative requires it. The machine is turned by hand; and it is desirable to have two speeds, one picture to a turn,



CABINET PRINTER.

and two pictures to a turn. This permits wide variation with considerable precision. Run about 100 feet through in five minutes.

Developing Positives.

The development of positives is similar, and the same apparatus is used, as in developing negatives, although different chemicals are recommended; developers which will give the clearest high lights and soft blacks in the shadows.

The high lights should be perfectly transparent, and the detail in the shadow fully developed, in fact, treat the film as though one were making a lantern slide.

The film may be toned if desired.

Chromogene Colors.

Some very pleasing effects are secured by toning solutions which act only on the dark parts of the film, that is, colors which act only on the silver deposits, leaving the clear portion of the picture unaffected. Of these, some of the best are chromogene colors. The effect on the canvas is clear white sky with all objects in one color.

Automatic Changing Tints.

In tinting lantern slides for the purpose of producing upon the screen gradual changes of color or tint, as, for example, a sunset, painting the parts with a solution of chloride of copper will

produce yellow; the same with a little iron, green; chloride of cobalt, violet; onion juice, brown. These colorless solutions used on the lantern slide gradually take their respective colors under the effect of the heat of the arc, but the slide clears again on cooling.

Outlines or photographic images made with a dilute solution of sulphuric acid are clear when first put into the lantern, but gradually appear black under the action of the heat of the arc, but clear again on cooling. Remember these are poisons.

PERFORATING.

The Perforations.

Of the holes which have been spoken of as being punched along each edge of the film in order to automatically register the pictures, three general shapes have been used—that is, a round hole, a round-cornered hole, and a square-cornered rectangular hole. The latter is much to be preferred. The round hole has been abandoned.

The film-feeding sprockets are cut by turning down in a lathe the face of the brass cylinders so as to leave two little conical ridges the proper distance apart upon its circumference. The cylinder is now put into a gear-cutting machine where the ridges are cut away in part so as to leave sprockets or teeth, the shape or pitch being determined by the diameter of the sprocket. This process produces teeth of rectangular base cross-section. Obviously the holes should be rectangular, otherwise, the tooth, in intermittently feeding the film forward in the lantern, as it does, by little jerks, takes the strain, not upon its advancing face, as it should, but upon the corners, as shown (eight times magnified). The error of such a method, that is, when a round-cornered hole is used with a

square-tooth sprocket, soon begins to manifest itself by little irregular white lines in the forward or attacked corners. Upon examination, these little irregular lines are found to be minute ruptures which continue to grow in length until finally the holes are torn entirely to the edge of the film, and while the picture surface face is still in good condition the film must be thrown away because it will not go through the projecting machine.

Rectangular sprocket teeth and rectangular holes, holes which approximate the natural cross-section of the tooth at the base, pull the film smoothly without damaging it.

Nor does the changes of temperature or humidity affect the feed or fit. A glance at the figure shows the reason for this. It is apparent that the face of the tooth comes squarely against the edge of the hole, which receives the entire strain. Films so perforated do, in actual practice, as one would naturally suppose, outlast the film having perforations of the other shape.

A perforation widely used at this time is a compromise of the two latter, *i. e.,* a round-ended rectangular hole with straight top and bottom edges.

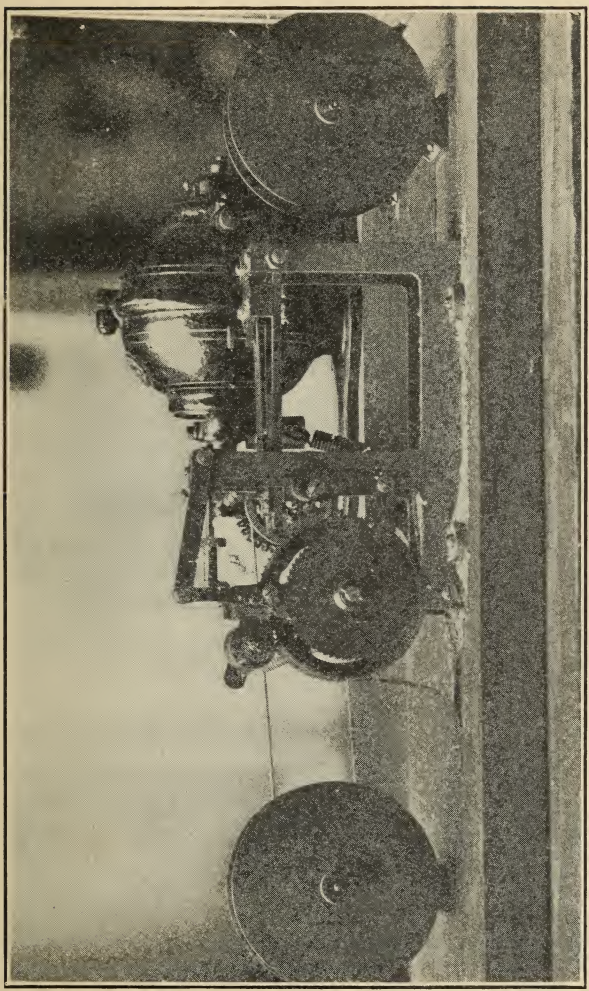
Different Widths of Film.

When motion pictures began first to attain public notice, there were three principal widths of film, *i. e.*, $2\frac{3}{4}$ inches, 60 millimeters, and $1\frac{3}{8}$ inches. The latter has come to be the standard everywhere, which is fortunate, for films made anywhere in the world will fit all projecting machines, no matter where made or where used.

Reciprocating Table.

The perforator built by Mr. Jenkins for punching the marginal rows of little holes in the film stock by which the ribbon is fed, and which insures automatic registration of the pictures, has a vibrating table hinged at one end on pin bearings, the other end carrying the tempered steel punch-plate. The table is raised about one-sixteenth of an inch by a cam pinching the film between the die-plate and the punch-teeth, which latter are firmly screwed to the frame. Micrometer adjustment of the spacing between the perforations is provided for by slightly moving the spacing sprocket (by means of knurled head as shown).

When the punch-teeth become dull from accident or long-continued use, any expert mechanic can sharpen them, as follows: Remove the plate having the teeth thereon, rest it firmly on a small anvil or other suitable support and gently upset the points with a light smooth-faced hammer.



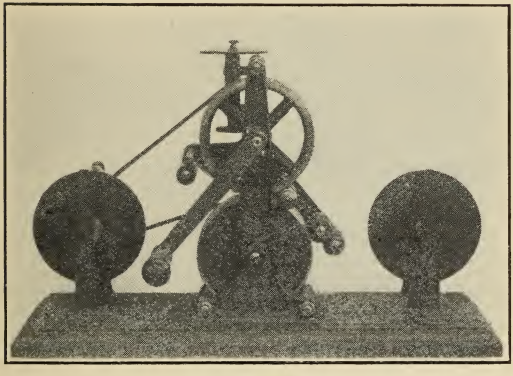
RECIPROCATING PERFORATOR.

After being sufficiently upset to prevent the teeth going into the holes without touching on any side they are finished on the ends with a smooth file very carefully held flat. Now replace the punch-plate, touch each tooth with a drop of oil and carefully and slowly force the teeth into the lower punch-plate, which will shear off the edges of the teeth and the punch is ready for use. This, when properly and carefully done, will then punch holes smooth and clean. If possible, the frame should never be disturbed, once it is set up. A magnifying glass will be of assistance in determining the condition of the punch-teeth at any time and also the character of the punched holes.

Rotary Punch.

Another punch, having the advantage of maximum rapidity possible consists of a drum or wheel having punch-teeth thereon, which step into corresponding holes in another drum located beneath the first.

The punch-tooth drum is, of course, not difficult to make as it can be cut in an ordinary gear-cutting machine, but the holes in the female drum are apparently not so easy. However, if this drum is made in three pieces, the center piece with deep slots in the edge of the flanges, and two steel rings slipped on over each flange to make the fourth side of the square hole, it is almost as easy to make



ROTARY PERFORATOR.

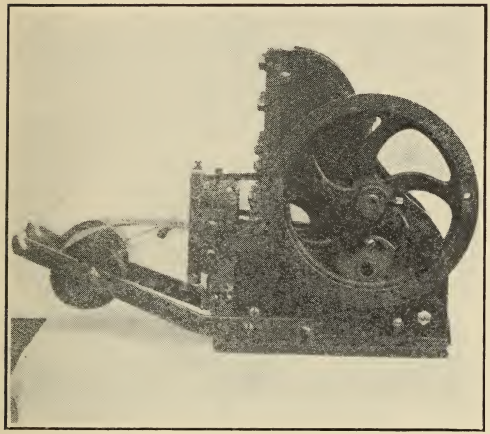
as the male drum, and is easily, quickly, and accurately done. A rotary punch will perforate about a hundred feet a minute safely.

Depue's Perforator.

The perforator built by Mr. Depue has vertically reciprocating punch-teeth, smooth-roll feed, and a pair of pilot-teeth which give absolutely accurate registration just before the contact of the punch-teeth with the film. This method gives the utmost accuracy in registration by micrometer adjustment of the distance between the pilot-teeth and the cutting punches. This machine has proved extremely satisfactory in actual use and punches 800 feet an hour without electric sparking. By running two films together, one on top of the other, 1600 feet an hour can be punched, both films coming out all right. It can be driven by a water motor, electric motor, or other suitable means. The feed rollers act by a rachet, one hole at a time, as nearly correct as possible. Then after the pointed pilot partly enters hole, the rollers are released and the film is free to move and adapt itself to the registering pilot.

Joining or Splicing Films.

In splicing, an end of the film is cut square across, one pair of holes beyond the edge of the picture, and, with a straight-edge held tightly down upon it just at the edge of the picture, the



DEPUE'S PERFORATOR.

gelatine is dampened with the finger and when almost surface-dry is gently rubbed, which will leave the end of the film bare for about one-eighth of an inch. If the gelatine is properly dampened it will be found to roll up under the thumb so as to leave the celluloid perfectly clean. Some operators use a piece of metal cut square across something like a chisel and push the gelatine off. The other end of the film is then cut square across and so that when placed under the bared end, celluloid surfaces together, the pictures and the holes correctly register. With the ends of the film held firmly in place, a corner of the splice is raised with the point of a knife and the splicing solution applied, by a touch only. The splicing solution should be applied as quickly as possible before the ether has had time to volatilize, and the film ends instantly pressed together and so held for a few seconds. Then raise the other corner of the splice and make a second application of splicing solution. A little practice and dexterity will result in good, smooth splices.

Splicing Solution.

Common commercial collodion with 20 to 25 per cent of extra ether added cannot be excelled for splicing celluloid strips. The application should be made with a small stick mounted in the cork, and not with a brush. Thick collodion will

not make good splices; it should be thinned with fresh ether occasionally. When acetone or amyl acetate is used as a splicing solution a "film-mender" is almost a necessity. Work on a glass or a piece of paraffine paper.

Laying a picture film alongside the two ends to be spliced is sometimes done to make the pictures inserted at each end of a blank piece correctly register after joining.

COATING FILM.

The coating of the film by the manufacturers of film stock is an interesting process, although concealed from the public generally. However, to reveal the method avails but little, as the most of success depends upon the formulæ and the minutiæ of the process. The film is slowly drawn, in the coating machine, beneath a hopper with a narrow lateral slit in such a way that the full width of this great web, 22 inches wide and anywhere from 400 to 600 feet long, is evenly coated. As it is drawn from under the mouth of the emulsion hopper it is carried along gradually with an ever-decreasing movement until it hangs in great folds from a little trolley track near the ceiling of the drying room.

Another method consists in carrying the emulsion hopper along over the surface of a stone or glass top table 200 feet long, upon which the celluloid has been spread and dried. After coating, the film is rolled up and passed through a machine which splits it into the proper width, the length, in the meantime, being measured by a little instrument which accurately records the number of feet passed.

A New "Celluloid."

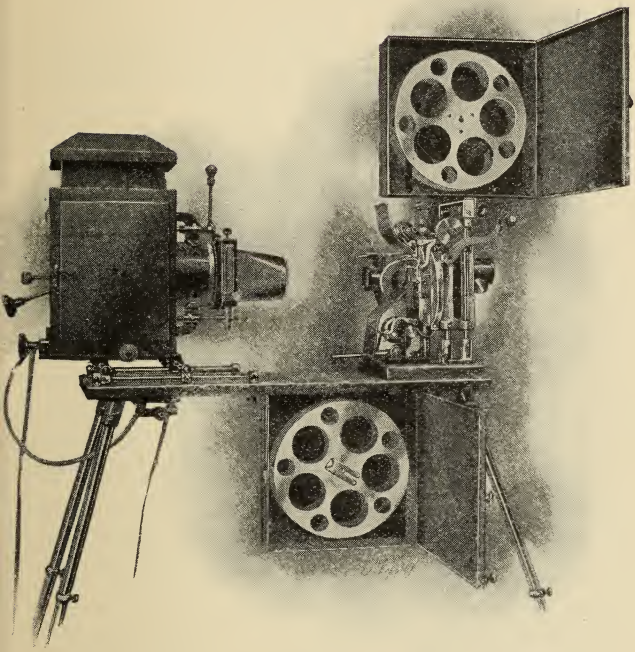
While inflammable celluloid, made of (vegetable) cellulose, is now used, there is good reason to believe that some other substance, possibly (vegetable) gluten, will, sooner or later, be the vehicle for carrying these little pictures, and this should prove a profitable field of research for the chemist.

PROJECTION.

Projecting Machines.

The projection of these picture strips is accomplished in a lantern fitted with a special attachment for feeding the pellicular band through the light, which is usually that of an electric arc lamp, as it will be remembered that the picture is scarcely one-fourth as large as an ordinary lantern slide and therefore only about one-sixteenth the area; in other words, to secure the same brilliancy on the canvas it is necessary to use a light many times more intense than for an ordinary slide.

Sometimes stereopticon projecting lanterns are fitted with moving-picture machine attachments so arranged that lantern slides and motion pictures can be projected alternately. The best practice, however, provides for separate machines, and for lecture work, dissolving stereopticons located above the motion-picture machine and farther over away from the operator. This gives easy and convenient access to all three mechanisms. A double-deck stand or support for the machines, and also for the metal boxes containing the necessary switches, cut-outs, etc., is desirable for a traveling outfit. This stand is then easily arranged on the backs



PROJECTING MACHINE.

of the theatre chairs; or on movable tressels, etc. In some cities this tressel support must be made of iron while in others wooden framing is permitted.

Pilot-Light.

A pilot-light should be located in a wall-socket under the stereopticon shelf of this double stand, to furnish light to work by when the arcs are out. An extension cord with plug and socket lamp with guard is also very handy as it can be moved about while the machine is being set up.

The Booth.

In inclosing the machine and operator in hanging curtains, it will be found convenient to have some false lens hoods made, considerably larger than the projecting lenses, and mount them on a board vertically arranged in front of the lenses. Slits in the curtain are pinned snugly around these false lens hoods, and the curtain never swings into the line of picture projection. These curtains should be thoroughly fire-proofed.

A Professional Machine.

In projecting machines, the first important consideration is a mechanism which is not hard on the film; is smooth-running and quiet; which permits of framing the picture without disturbing the window, lens, or picture on the canvas; and that

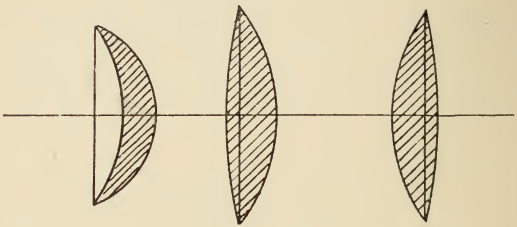
will accommodate lenses of different foci. The rewinding device in the magazine should be one which can be trusted, and, if a belt is used, it should be so made and fitted that it will not come off accidentally. The machine should be turned by hand so as to require the attention of the operator. When he stops turning, the film stops, whereas, in case of a fire, a motor would continue to feed the inflammable film out of the fire-proof magazines and into the flame after the operator had fled.

Cracked Condensers.

Another important consideration in a projecting machine is the ability to change the condensing lenses quickly, especially the one close to the light, and substitute a new one for a cracked one. No suitable devices have ever yet been found which absolutely guarantee that the lens next to the arc will not break, and obviously, this may happen soon after starting the exhibition; and in this event, if the lenses cannot be quickly changed, a whole two-hour performance must be spoiled by a cracked lens. It has been found that to have the back lens supported between asbestos-lined rings to prevent the glass coming into contact with metal materially helps to prevent breaking. Have extra lenses at hand and ready to slip in quickly.

Triple Condensers.

Many motion-picture machines are fitted with but two condenser lenses, although the best results are obtained with three condenser lenses; one concavo-convex and two thin double-convex separated by air space; for motion-picture use only, however.



Projecting Lenses.

Have projecting lens rings in stereopticon large enough to take in 1/2, 2/3, and 4/4 lenses easily by the use of adapter rings; and in the motion-picture machine a projecting lens tube with rack and pinion, and with interchangeable lenses of different focal length.

Magazines.

Fire-proof metal film-boxes, or magazines, should be used on every motion-picture projecting machine, in fact, are required by the fire regulations of most cities.

Lamp House.

The lamp house should inclose the arc so completely that sparks from the carbon, or incandescent pieces snapped off of the carbon by the striking of the arc, or the sputtering of the arc, cannot possibly fall down and get outside of the lantern. The majority of the few fires which have occurred in theatres, which have been chargeable to motion-picture machines, have been caused by pieces of hot carbon falling from the lamp house into the film supply box. If a lime-light is used, this is even more important because the lime breaks to pieces and the pieces fall, setting fire to any inflammable material with which they come in contact. These little incandescent pieces of carbon or lime falling on varnished, lacquered, or enameled surfaces seem to generate a gas which causes them to jump off, carrying the danger to other more inflammable parts. The lamp house of the motion-picture machine should have a spring-closed door.

Combination Machines.

Some projecting machines are made with the lamp house arranged to slide laterally to bring the lamp out of line with the projecting lens of the motion-picture machine, and into line with the projecting lens located on the side of the projecting machine so that the ordinary magic-lantern slides

can be used. A better practice seems to be, however, a combination of stereopticon and motion-picture lanterns which are distinctly separate.

Ventilating.

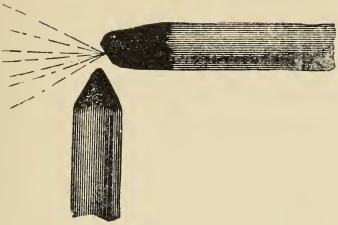
After 15 years' experience, in which different kinds of ventilated lanterns have been tried, it has been found that the coolest lantern is an absolutely closed-in body, back, bottom, and sides, of thin metal, without lining, with little chimneys or flues over the arc and leading up to the top, and a perforated metal bottom covered with a fine wire screen. Only spark-tight lanterns should be used, not alone for your own protection but to pass inspection. For the same reason a bucket of water should be at hand to extinguish an incipient fire, before a larger fire starts a panic.

The Lamp.

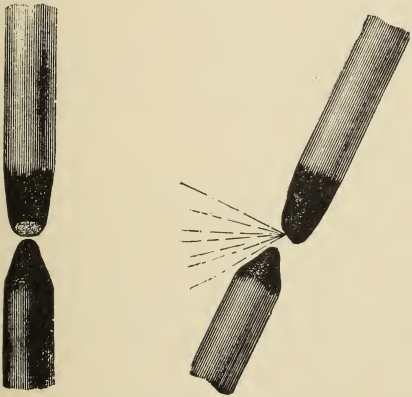
A hand-feed arc lamp is the most common source of illumination, although oxy-hydrogen or calcium light is sometimes employed, and even acetylene gas under pressure may be used with a very small screen.

The Nearnst lamp gives a very white light and is a very good light for home use when 3- or 4-foot screen is used; and works on 110 to 220 direct or alternating circuit.

Electric lamps require a pressure of 45 to 60 volts. Surplus voltage is taken up in a rheostat



STEREOPTICON ARC.



MOTION PICTURE ARC.

(in series with the lamp), with an attendant generation of heat in the rheostat.

To successfully illuminate a large screen a heavy current is necessary and a great deal of heat is generated in the lamp, which endangers the film owing to its inflammable nature, and for this reason protection should be provided.

The 90° arc lamp is ideal for stereopticons, that is currents below, say, 30 amperes. For motion-picture machines, carbons in line hold the arc the best when 30 or more amperes are used.

The hottest or brightest carbon is the positive and should be the upper carbon. If this is not the case, change over the terminals, or throw the switch over, if the machine is provided with a two-throw pale-changing switch, a safe and convenient arrangement.

Heat Shield.

A swinging metal shield between the condensers and the film window, operated by a foot treadle, by hand, or automatically from the crank, or both, is the usual method, though a glass tank containing water, glycerine, or a saturated solution of alum placed between the condensers and the film is sometimes used. A cover-glass close to and over the film window is also considered good practice and some machines are so made. The glass cover on both sides of the film where the heat strikes it,

not only prevents a great deal of heat from striking the film but, being closed in, the film is robbed of the necessary air or oxygen to support combustion, so there is no fire, although the film may wrinkle and ultimately smoke if it stands still in the window long enough.

The Carbons.

Use cored carbons of the highest grade, "Electra" brand is the best, separated 3/16ths to 3/8ths of an inch and pointed before use. Use 5/8 carbons above and 9/16 carbons below in motion-picture machines. Soft carbons give the best results. A soft carbon may be distinguished from a hard carbon by breaking it, although some little experience is required. The soft carbons show a dull black broken end, while the hard carbons exhibit a slight silvery gray appearance.

The two carbons are set in line and at an angle to the axis of the optical system, or set at right angles with each other (the former always in motion-picture lamps) in both cases, the lower one being a little in advance. This gives a very bright crater in the back focus of the condensers.

Lamp Adjustment.

The motion-picture lamp should have longitudinal, lateral, and vertical movement, and positive means of securing this adjustment after the lamp is hot and the machine in motion. The lamp

should also have a carbon adjustment in every direction. A lever movement of the lower carbon holder is a great convenience for quickly striking the arc, although some use a carbon and touch it between the two carbons of the lamp.

In adjusting the machines, it will be found more practical to first secure an approximate focus then a white light on the canvas, next sharp focus of all of the projecting lenses, and then proper registration on the canvas. Make final focus on a good focusing slide (made with sharply-defined lines and lettering) and then let the focus alone during the whole show.

Use a piece of mica with sharply scratched pin lines on one side for focusing the motion-picture lens, with the film window open.

Everything should be tested before the doors of the theatre open so that any little troubles may be corrected without loss of confidence by the audience in your ability and their own safety.

Oxy-Hydro Light.

When oxy-hydrogen light is used in the stereopticon, always turn on the hydrogen first and light it, next turn on the oxygen, slowly, and then manipulate the valves until you get clear white light on the canvas. The lime should be turned as frequently as necessary to prevent deep pitting. In America the black tank is hydrogen,

the red oxygen; in the British Isles the red tank is hydrogen.

Popping.

If there is a sharp pop when dissolving, it is caused by the excessive flow of oxygen, or an insufficient quantity of hydrogen. Turn on more at the tank, and if it still pops, adjust the overflow valves of the dissolver; if it continues to pop, clean out the grooves of the dissolver. If these precautions are followed and popping continues when dissolving, the chances are that the oxygen tube is on the hydrogen nipple.

Calcium Tanks.

We earnestly discourage the use of calcium (oxy-hydrogen) light in theatres. Its use is dangerous in the hands of any but the most experienced and careful operators, not so much from any inherent danger in the apparatus itself, but because the popping which sometimes accompanies its use may excite the latent panicky feeling of the audience and with disastrous results. The very best rule is never to use oxy-hydrogen light where electric current can possibly be had. Many theatres will not allow oxy-hydrogen tanks on their premises at all, while most of those who permit the use of this light require the location of the tanks outside the building.

Rheostat.

The selection of a rheostat for the electric arc lamp is not altogether the simple matter one might at first suppose, the danger being overheating. There is quite a variety, in construction, but the general plan is the same, *i. e.,* wire enough and of such a gauge as to carry only the minimum current when all in. To increase the current flowing, that is, to increase the light, coils of wire are cut out by a sliding contact switch, and usually with a rapid rise in heat often to a dangerous point.

The ideal rheostat is one in which the minimum wire in circuit gives the minimum current, and additional current, that is, increased illumination, is obtained by cutting in more wire in parallel. In such a rheostat the wire does not get hotter when more current is carried, although the illumination is increased. Switches and movable contacts have no rightful place in a rheostat; heavy binding posts for lugs only should be used. There is no need for change during a show. The rheostat should be inclosed in a perforated screen or wire cover, and should be raised above the floor 2 inches or so.

Loosely-Fitted Parts.

Everything about the lantern should be made stout but loosely fitted as the heat is almost sure to warp and tighten something at a critical mo-

ment, and the exhibition must be interrupted while it is being corrected.

Electrical Connections.

The connection is a very important part in any lamp and when installing an outfit great care should be exercised to see that every electrical connection from the main feed wires to the carbons is tight. A loose contact not only makes the light unsteady but is also a source of danger; arcing and heating occur, and it may result in a broken circuit in time which could cause a fire. See that every contact from mains through the rheostat up to the carbons is tight.

Fuses and Cut-Outs.

All fuses should be of the inclosed cartridge variety, and held between metal blades, and be put in by hand, not with a screw-driver.

Electric Wiring.

All electric wiring should be done by an electrician, but a few general observations may not be amiss. Put all knife switches, cut-outs, and binding posts in asbestos-lined metal boxes with hinged lids. Use insulated grommet rings where wires enter the box. Slate is a safer base for knife switches than porcelain for travel; it is not so fragile, and is required in many cities. All knife

switches should be placed vertically and should open downward. Use insulating tape and tubes freely wherever there is a chance of a bare connection, wire, or other electric conductor coming in contact with any metal parts.

Iron Stands.

In some cities, an iron stand for the motion-picture machine, and sometimes the stereopticon, is required. In the theatres in many cities of the United States operators and machines must be inclosed in an iron house. This latter applies only to motion-picture machines, however.

Three-Wire Circuits.

In using three-wire mains, with stereopticon and motion-picture machine, put the stereopticon on one pair and the motion-picture lamp on the other pair of mains, alternating or direct current. The two outside wires are 220 volts which would, if used, burn up the rheostat or blow the fuses. Connecting between either outside wire and the middle wire gives 110 volts, the proper voltage for an arc with rheostat in circuit.

Registering.

The registering of the pictures should not be done on the screen. Look at the picture in the window. The focus ought to be secured before

the commencement of the entertainment, and does not need to be changed until either the machine or the canvas is moved.

There is always enough light from the pilot-light, to register the picture in the window of the machine, at the beginning.

In adjusting, whether it be motion picture or stereopticon, white light on the canvas is secured by pushing the arc well forward until the whole canvas appears bright and white. Bluish semi-circular blotches are eliminated by moving the lamp vertically or laterally.

Optical Laws.

Moving-picture lanterns obey the same laws governing other projecting stereopticons. That is, the illumination of a screen falls off as the square of the distance to the screen; the loss of light by moving the lamp back from the condensers is as the square of the distance that the lamp is moved; the picture rays and the light rays should coincide; the light rays should cross in the objective; and putting a plano-concave lens between the picture and the objective lengthens the focus of the objective and reduces the size of the picture on the screen. The projecting machines are usually placed in balconies well back in order to get satisfactory enlargement of these small pictures on the

canvas. The lower floor or the first balcony of the house is best. The top gallery is not suitable as a rule.

The Screen.

For a screen any white opaque material is suitable, and much more satisfactory than a transparent one. Nothing else is so good as a zinc white surface, though it is expensive. The formula in the back of this book is excellent.

Signaling Device.

A very satisfactory signaling apparatus between lanternist and speaker, is the electric signal customarily employed (a dry cell and push-button, and buzzer), with the exception that a tiny electric lamp is substituted for the "buzzer." This makes no noise whatever, is entirely efficient, and can be mounted anywhere.

The Acousticon is an excellent "cue" device, especially for lecturers, as the operator can distinctly hear everything the speaker says.

Announcements.

The accepted plan for conducting an entertainment of animated pictures is to have each picture announced by a special slide in an auxiliary lantern before the picture is thrown upon the screen, or by an announcement photographed on the beginning of each film. This enhances its acceptability

and the interest of the audience in the picture. Appropriate music is usually rendered during the exhibition of the picture. During the intervals between the pictures the auditorium should be but dimly lighted. This will prevent the pupils of the eyes of the audience contracting, which would cause the pictures when first projected upon the screen to be less readily distinguishable. If the films are spliced together so that proper registration is maintained throughout and all wound on one large reel, the intermission between the pictures need not be so long as would be the case if each film had to be put into the machine separately. Splice blank black pieces between picture ribbons to enable the operator to stop the feeding mechanism before running into the following picture. Always start turning the crank before raising the shutter to let the light strike the film.

Put white or red strips of 6 or 8 feet at beginning of every reel of film with black at the last end. The former shows which reels must be rewound, and the latter prevents letting white light on the canvas.

Provide multiplying rewinding device. It is preferable to have it in portable form.

Always keep films in metal boxes with tight fitting covers, to protect them against dust and dirt which will scratch the film later.

Size of Pictures.

The following table gives the various sizes of pictures to be had with different objectives, using a standard film:

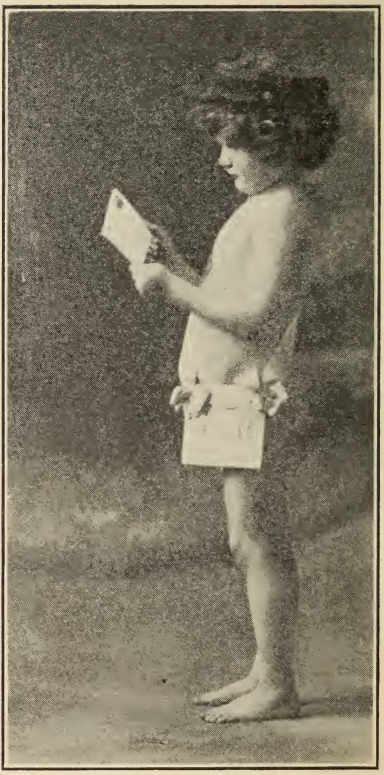
Size of lens.	Distance in feet from objective to screen.									
	20	40	60	80	100	120	140	160	180	200
Extra wide angle	6½	10	13½							
Wide angle	3½	6⅔	10	13⅓						
¼ size		5	7½	10	12½	15				
⅓ size			6	8	10	12	14	16		
½ size				6	7½	9	10½	12	13½	15

The following table gives the various sizes of pictures to be had with different objectives, using a picture 3 inches in height:

Size of lens.	Distance in feet from objective to screen.										
	10	20	30	40	50	60	70	80	90	100	110
Wide angle	6	12	18								
¼ size		9	15	19							
⅓ size			12	17	19						
½ size				12	15	18	20				
⅔ size					12	15	18	20	22		
4-4 size						12	15	18	20	22	24

Trunks.

For many reasons trunks and heavy leather cases are the best carrying devices for motion-picture apparatus. Stout, that is, extra well-made trunks, are by far the cheapest in the long run. It is almost beyond belief, certainly to the layman, how soon a piece of apparatus is broken in even the best trunks. Smaller trunks and several of them is better than fewer large trunks. Total charges are a little more, but the trunks and apparatus last much longer. The transfer and baggage men handle them easier and don't drop them so far or so heavily.



THE OPERATOR'S RESPONSIBILITY.

Every moving-picture machine operator, and those who are responsible for his employment, should appreciate the vitally responsible position the operator occupies. Not only is he engaged in a business where carelessness may result in great monetary loss, but he has in his hands the lives of his audience; as much so as the engineer of a train. Carelessness is criminal, and the operator who holds down the shutter with a brick, and runs the machine with a motor, while he sits by smoking cigarettes and reading a novel should have his license instantly revoked and be held liable for criminal negligence. The operator's first duty is to so conduct himself as to invite confidence and keep his audience passive. A little excitement may, at any moment, start a panic which might cause great loss of life.

The business is young and experienced operators scarce, it is admitted, but this should only make employers more careful in their selection of the men into whose hands they put so much responsibility. Neglect of this very reasonable precaution is the cause of the onerous restrictions so hastily applied to this business, and which reacts against the careful and conscientious as much as the care-

less operator. This was the cause of the Charity Bazaar Fire in Paris in which so many lost their lives. The Iroquois Fire in Chicago was caused by an unprotected arc light in the wings of the stage. A piece of drapery or curtain (not fire-proofed) was blown into the arc. The result was the most appalling in the history of theatre fires. A protected arc or fire-proofed scenery, or both, as required to-day, would have prevented it. So simple a thing as the popping of the oxy-hydrogen light is claimed to have been the immediate cause of a panicky feeling in the audience at Boyertown, and therefore indirectly the cause of the subsequent fire and fearful loss of life.

The Theatre's Responsibility.

It is only fair to say that distrust of the motion-picture operator's ability is not usually the chief cause of a panic in most theatres but really is the audience's belief that the exits are not sufficiently large and accessible and that the theatre itself is therefore a veritable fire trap. That this is true is obvious as a motion-picture operator's mistakes never disturb an open-air audience, for in this case his troubles are his own and works no danger or loss to anyone else.

Without doubt all theatres and public assembly halls should have emergency exits of more than usual ample opening, which should open outward.

and onto still wider, straight stairs. These openings should be clearly marked with red lights, be always unlocked and unbarred, and be frequently used as ordinary exits to familiarize the public with their location and purpose. Every piece of drapery or canvas, and every piece of wood about a theatre or public hall should be fire-proofed and fire-protected.

Municipal Regulations.

The rules and regulations governing the use of motion-picture machines in different cities are so varied as to be impossible of compilation, but in a general way the building itself must comply with the regulations governing theatres and other places of public entertainment.

To this are added certain requirements applicable specially to motion-picture machines alone.

Thus, in some cities a metal booth; in others a booth lined with asbestos and tin, with a spring-closed door, must be provided to inclose the machine and operator, while others permit "an approved" inclosing curtain, thoroughly fire-proofed, of course. A bucket of water and in some cities fire extinguishers must be kept in the booth. Iron supports for the machines is often, though not always, required. Many cities require a licensed operator, and some an operator with a considerable term of experience.

The prudent course to pursue is obviously to make inquiries regarding the local requirements early which would prevent the pre-emptory stopping of the entertainment when too late to comply with the inspector's requirements.

Inspectors are, as a rule, very fair and reasonable fellows, and will help rather than hinder the skilled operator who shows a hearty willingness to comply with such regulations as he is required to enforce, and will often aid by valuable suggestions, for the regulations are always, of necessity, more or less elastic and some discretion is allowed him.

The loaning of personal licenses, and other efforts of unscrupulous operators to defeat or evade reasonable requirements is just what causes the enactment of stringent regulations working a hardship on conscientious operators as well as dishonest ones.

Booths should be eight feet high, and well ventilated, as a comfortable operator means a careful, alert operator.

Putting the motion-picture canvas at the street end of the 5-cent theatres and the machine at the other end of the auditorium is an added feature of public safety, and often otherwise the best arrangement. The aisles should then be on the sides.

GENERAL.

Step-by-Step Machines.

In the construction of projecting apparatus it is well to observe that if the film is fed step by step, then the more the period of illumination or rest exceeds the period of change, the more brilliant the illumination (if a shutter is used) or the sharper the picture (if no shutter is used).

Geneva Movement.

The modified Geneva stop or mutilated intermittent gear is very simple, and entirely efficient for feeding the film at speeds not exceeding, say, 20 pictures per second. Owing to its simplicity it has come into more general use than any other form of film-feeding mechanism.

Turning by Hand.

In a hand-operated projecting machine, the lanternist as he watches the picture on the canvas has the exhibition entirely under his control and can turn the crank quickly or slowly, giving to the picture the effect of natural performance of the action involved. A piece of machinery can be photographed slowly and afterwards reproduced rapidly, thus falsifying the record. A train may

be made to run at fearful speed by turning faster, and a boxing match made ridiculous by turning slowly.

Scratches.

The available life of a film is greatly enhanced by keeping the picture surface as free as possible from the scratches or vertical streaks, and the little flashes of light where the gelatine has been pulled off. This is best done by the employment in projecting machines of a tension plate having the tension only along the edge of the film, that is, a pair of narrow polished metal strips so located that they bear upon the edges of the film over the holes. Springs are arranged to increase or decrease the tension at will, giving latitude in the pressure. It will be found that a tension of this kind on projecting machines very greatly lengthens the life of the film.

Colored Backgrounds.

A new feature in this work which adds to the charm of a successful exhibition of some pictures consists in projecting with an ordinary magic lantern a view of the background in color, while in the dark center moving objects alone are projected, for example, a picture of a gold frame in which the motion picture is projected. Again, a colored stationary picture may be used for background of a moving picture; as, for example, a

waterfall in a colored scenery background. Or a glass mask-tinter, coloring only the stationary objects in their natural tints, can be mounted over the film window.

The same idea is carried out to wonderfully enhance the beauty of the moving pictures by exhibiting with the motion-picture machine pictures on the black circle inside chromatic rings projected with a secondary lantern.

Colored Film.

Although costly to make, charming effect can be attained by coloring the subjects on the film itself. The colors which experience has demonstrated as generally best suited for tinting are the reds, pinks, and greens—the warm end of the spectrum.

These pictures when projected upon a mist bank out of doors produce pretty effects, as the performance seems to be taking place in "thin air."

Backward Rotating Wheels.

A peculiarity of chronophotography is sometimes observed in pictures of wheeled vehicles, the wheels appearing to revolve slowly backward. It is an odd optical effect and purely accidental, caused by the vehicle going just a little too slow for the pictures. Often the front wheel is seen to rotate forward and the rear wheel backward.

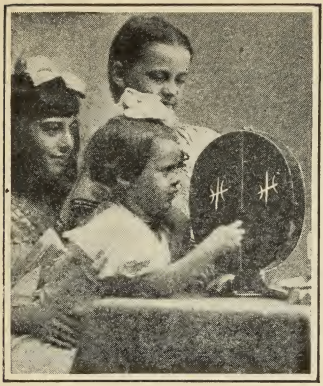
The cause, though simple, is not generally un-

derstood, and as the question is frequently asked, the explanation is here given.

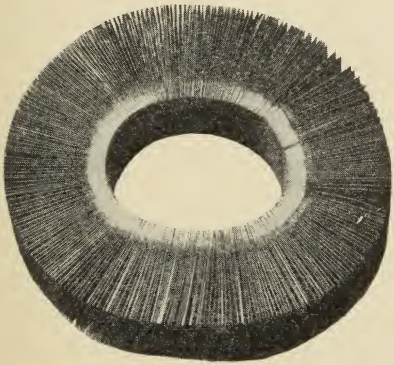
Imagine for a moment that the spokes of a wheel are photographed just as each succeeding spoke occupies the spot the preceding spoke occupied when the photograph was made. Evidently all the spokes will always appear on the canvas in exactly the same place and obviously there will seem to be no rotary motion whatever of the wheel. If, however, the photograph is made a little bit faster so that each spoke does not quite reach the position the preceding spoke occupied when the picture was made, the effect will be of the wheel rotating backward. On the other hand, however, if the picture is made a little slower so that each spoke will occupy a position a little in advance of the preceding spoke when the exposure was made, the wheel will, in this case, seem to rotate very slowly forward. As the front wheel of moving vehicles is smaller than the rear wheel, it naturally revolves a little faster, and this accounts for the paradoxical effect of the two wheels of the same vehicle rotating in opposite directions at the same time.

Flickering.

The difference between flickering and shakiness of pictures is not generally understood. Shakiness or unsteadiness of the picture depends wholly



THE PHANTOSCOPE.



PHANTOSCOPE PICTURE ROLL.

upon the manner in which the picture ribbon is fed; thus, if the film moves intermittently and each picture moves exactly to the position occupied by the preceding picture, then there will be no shakiness of the picture on the screen,—it will be absolutely steady. On the other hand, if a shutter is employed and it is rotated too slowly a flickering or "winking" is produced which is entirely independent of whether a picture is being projected or not. Thus, suppose we run a shutter machine as usual, except that no film is put in, that is, no picture is projected, the flickering is now just as much in evidence as before, although the illuminated square on the canvas is perfectly steady, having no movement whatever. If, while watching this illuminated square of canvas, the machine is gradually slowed down, the flickering is more and more noticeable until the eyes begin to ache. Thus, the remark frequently heard that some "pictures are so shaky" that they hurt one's eyes is erroneous, for, as just explained, no matter whether the pictures are shaky or not, if the machine is run fast enough, or the shutter is removed, no ill effect on the eye is noticeable. This injurious effect is probably due to the incessant contracting and relaxing of the muscles controlling the pupil of the eye. When the picture, or the light alone, as the case may be, is thrown upon the screen the eye immediately, and unconsciously

contracts so as not to admit too much light. The contraction is quickly followed by darkness as the shutter obscures the light of the lantern. The pupil immediately expands to gather as much light as possible. This is again followed quickly by light and consequent contraction, and again darkness and expansion, and so on until the eye fatigues from the excessive and unnatural exertion. No eye fatigue is ever experienced when a shutterless machine is employed, for the reason that darkness does not intervene during the changing of the pictures and consequently the pupil is motionless.

Obviously then, if a shutter is used, the shorter the duration of black to white, the better, and, therefore, if the light is cut three or five times during a revolution of the shutter, this will materially help.

If the machine is so built that the period of rest of each picture is, say, four or five or more times longer than the period of substitution of the pictures, then the picture itself is so firmly impressed upon the retina of the eye that the impression of the smudge of the pictures changing place is imperceptible and the eye sees only the picture, and no fatigue of the eye is ever experienced. An impression of strong light on the retina of the eye so deadens the sensibilities that another impression is not possible until sensitiveness is again acquired by the retina, a phenomena known as persistence

of vision, and without this no motion pictures would be possible by the usual means.

Crank Machines.

In crank machines the feed of the film, that is, the distance the pictures are pulled down each time, does not in the least depend upon the crank pin as one would at first glance suppose, but entirely upon the rotation of the sprocket wheel which takes up the slack. Thus, if the sprocket did not rotate at all the crank pin might turn on forever without moving a single picture into position. However, the length of time that each individual picture shall remain at rest, that is, the proportion of rest to movement, depends entirely upon the location of the crank pin. This is readily seen if one imagines the pin located at the center of the crank head, when it is obvious that there would be no period of rest at all, the film would be fed forward continuously, while moving the crank pin from the center begins to give an intermittent pull which increases as the pin is moved farther and farther from the center. Therefore, changing the size of the sprocket changes the size of the picture; changing the proportion of the gears connecting the sprocket and the crank-head shaft changes the size of the picture; but the period of rest of each interval depends wholly upon the distance of the pin from the center of the crank head.

Automatic Coin Controls.

A very simple automatic-actuated coin-controlled device consists of two terminals of a broken circuit held apart by springs the right distance to prevent the coin passing between them. When the proper coin is dropped into the gap between the terminals the circuit is completed and so remains furnishing current to run the motor, light the lamps, etc., until, say, a pin fastened to a suitable part of the mechanism shall have completed the circuit and striking against the coin the coin drops through, breaking the circuit, stopping the motor, etc., and again resuming its position for the reception of a second coin. It is very simple and entirely satisfactory for small currents. For heavier current it should act as a relay to close a circuit actuating a heavy switch, a switch of the "snap" variety to prevent arcing.

Nickelodeons.

Nickelodeons, the miniature five-cent theatres in which current events, comedy, and even drama is furnished in motion pictures, are a motion-picture creation. Many store-rooms on prominent streets are suitable or can be made so, though some are very elaborate affairs, especially the fronts. Red predominates in the color scheme, the whole interior preferably red. Simple hardwood chairs are usual, and few enough (say, 199), to avoid the

theatre license, an amusement license only being required. A small balcony, or elevated platform, is arranged in the back of the room and inclosed permanently or with curtains. Here is located the motion-picture machine and sometimes the phonograph or other music machine used to attract custom. It is well to thoroughly acquaint oneself with all regulations bearing on the subject before beginning to prepare such a place. The pay-roll should provide for a manager, operator, box-office, and door attendant, and a general utility man. The motion-picture films can be rented, on reels ready to use in the machine. To change the bill often is considered the best and most profitable practice by the majority of owners. Show films take the best, although all kinds are employed, the public taste varying with different places.

Reverse Pictures.

Reverse pictures are humorous, and always popular. For instance, in a bathing scene, as pictured upon the canvas, one sees the bathers walk out upon the spring boards high above the water, and, momentarily hesitating, they dive off promiscuously, plunging into the pool to the accompaniment of much splashing. This is very pretty, but in a moment the operator feeds the picture through the machine in inverse order, with the following curious and amusing result: At first

the water appears smooth, then there is a great splashing, followed by a smooth surface again out of which instantly shoot the bathers, feet first, one after another, singly and together, in startling confusion, and go sailing upward in graceful curves and ever decreasing momentum, just alighting upon the spring-board and back off down through the railing. If one has never seen this scene reversed it will be difficult to conceive the comical sight these bathers present popping out of the water feet first. The method employed to accomplish this astonishing result is simplicity itself. All the preparation necessary is to mount a rectifying prism in front of the projecting lens. A lantern slide, as is well known, to appear right side up on the screen must be put in the lantern wrong side up. This is equally applicable to the animated picture-ribbon lantern. Consequently, the strip is fed through the machine with the subjects standing on their heads. Now to begin at the other end of the ribbon, so as to make the order of events in inverse sequence, puts the ribbon through the machine the right way up,—heads up. But the picture on the screen is upside down. To invert it a prism is put in front of the lens, which rectifies the picture on the canvas.

Reverse pictures may be obtained direct by making the exposure with the camera wrong side up.

"Crazy Pictures."

The "Crazy Pictures" which have been used with such telling effect in the Burton Holmes' "Travelogues" and have been brought to such a state of excellence by him, are secured by making single exposures at longer or shorter intervals, covering the required time, say, a trip through a lock canal, a trip through a Norwegian Fjord, etc. For these photographs and other accelerated pictures, the camera is made with a small folding handle attached to a part of the film-feed mechanism, making one revolution per picture.

Trick Pictures.

Other erratic, unnatural scenes, such as tumbling cans, self-acting tools, etc., are made thus: Take the marching battalion of tomato cans. Put them in ranks and files, make one exposure, and then move all the cans forward a little and make another exposure, and move forward again and expose, and so continue until the cans are close up to the camera, then make them "Right wheel, halt," etc. Reproducing them in the motion-picture machine produces a fine effect. Similarly, a piece of chalk can make a picture without human aid, a saw will cut a board off by itself, etc. The variety and possibilities are endless.

Dummies.

There are almost as many different methods of making these eccentric pictures as there are pic-

tures. Some of the first were intended to be historical. For example, the execution of Mary, Queen of Scots, was made in this way: Property soldiers were grouped back of the headsman's block; the executioner stood by leaning on his broad-axe; the Queen was lead in, with hands tied behind her back; she kneels and lays her head on the block. At this point, the camera is stopped and a dummy takes the Queen's place at the block; the camera is started again and down comes the axe and the dummy head rolls off into the sawdust. In the reproduction this substitution is not easily detected.

The substituting of a dummy for a real person is the basis for a great number of all sorts of trick pictures, for example, the one in which the preoccupied man is run over by a steam roller, is flattened out by the passing of the heavy machine, but afterwards gets up and goes on again unconcerned.

Mystery Pictures.

The mystery and vanishing pictures are made in various ways; by stopping the camera and substituting slow photography; by splicing different films; by running the film backward, etc. Other methods depend on optical properties not so widely known. To illustrate: A camera is focused on a given setting. A projecting lantern is brought to a focus at the same plane as the camera lens, and

in such position that there is a blank back of it. Now, when the light in the lantern is turned on gradually, during the performance, any picture in the lantern is photographed by the camera although not visible to the operators. Another method is to locate the two parts of the mystery picture subject back of and at one side of a plain glass plate set at right angles. The two subjects are lighted in turn and naturally are photographed in like order.

Stereoscopic Effects.

Many motion pictures produce quite striking stereoscopic effects, most frequently appearing in pictures taken from a moving vehicle, as a boat or from a train. It is caused by the preceding picture being held by persistence of vision until the next picture is thrown on the eye. Thus, each picture is made so that one sees a little further around the nearby object, which gives a stereoscopic effect.

Stereoscopic Motion Pictures.

A number of more or less successful attempts have been made to produce motion pictures stereoscopically, but it is a question whether it is actually worth while, for the effect of distance is already quite well rendered because nearby objects pass in front of distant objects, and mental process does the rest.

Stereo-Methods.

However, in nickelodeons, it is possible to project by means of a double lantern, a right and left stereoscopic picture superposed on the same canvas, coloring them, respectively, red and green with tinters. The resultant picture is a blurry smudge on the canvas but instantly springs into a monocrome (black and white) stereoscopic picture when viewed through red and green tinters held before the eyes. These tinters may be mounted in any suitable form, one of which is a paper fan, and such are now available, one side bearing an advertisement. These fans can be given to each patron at the door, used to view the pictures, and may afterwards be taken away as souvenirs. The advertisement on the back of the fan is an additional source of revenue. These tinters and the fans have recently been put on the market.

Motion Pictures in Advertising.

The catchy character of "life motion pictures" was soon recognized by advertisers and was promptly requisitioned.

Almost every city now has an advertising stand employing moving pictures wholly or in part as their attraction. The methods in vogue are but simple modifications of ordinary lantern advertising practice. Usually there are two lanterns, one to project moving-picture advertising films, while

the other lantern is employed to fill in the gap with single-slide advertising pictures or pictures of purely entertaining character. Quite frequently a slide is used in the secondary lantern which projects above and below the moving picture on the screen the name of the article together with the address, etc., of the manufacturers. The moving picture is thrown upon the prearranged black blank on the screen.

Election Returns and Announcements.

A little "wrinkle," for rapidly producing announcements of current events, as war news, elections, etc., on a lantern canvas, is to write the desired announcements with a typewriter, as needed, on film, and while the ink is still moist to dust it over with a tuft of cotton dipped in finely-divided lamp-black. The letters will appear in black against a white canvas.

The same method can be advantageously applied by engineers and draughtsmen in their blue printing. Thus, the impression of a rubber stamp on a tracing, as is well known, will not show on the blue print satisfactorily. If, however, lamp-black is dusted on before the ink dries, the stamp will come out very plain indeed.

Making the lantern pictures on film negatives and joining them in a strip to be printed from, the positives afterward being joined to the moving-

picture strip, is a labor-saving scheme worthy of adoption, for the pictures can be drawn into position for projection, one at a time, afterward to be followed in regular order and without intermission by the moving pictures.

Endless Chain.

An arrangement for the secondary lantern which has been found to be very convenient in advertising lantern work is putting the slides in an endless chain by means of thin metal carriers in which the slides are held. These are made so that the slides are interchangeable, being easily and quickly inserted or removed from the carrier. A vertical attachment for the lantern is preferably employed. An automatic arrangement for changing the pictures adds to the convenience, and saves the expense of a helper.

" Keystone " Pictures.

In the projection of pictures in some situations, for instance, where the screen is much higher than the lantern, the picture will be " keystone-shaped." This can be remedied by inclining the picture slide in the carrier so that it shall stand in a plane parallel to the plane of the screen. This will cause a portion of the slide to be out of focus, but if the screen is not too much above or below the lantern, and the center of the slide is sharply focused, the top and bottom of the picture will be

so little out of focus that no serious objection will be found thereto. Sometimes it is found impracticable to lean the slide-carrier forward to counteract the upward inclination of the lantern, in which case hanging the screen so that its bottom edge is drawn well back, making the plane of the screen and the plane of the picture parallel, will accomplish the same result with entire success and better focus.

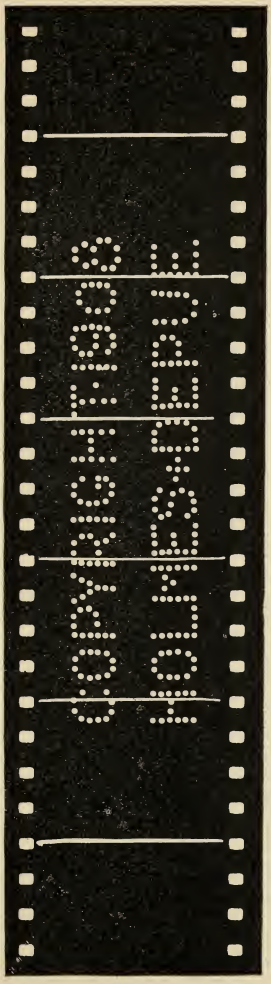
Copyrighting Films.

The question of copyrighting films to prevent their being pirated has been the subject of much controversy, and with many and varied conclusions. And until the matter is legally adjudicated, it is doubtful whether any one really knows what is necessary to secure protection; that is, whether recording the title alone is sufficient; whether short pieces of film will suffice, or whether to fulfil the requirements of law it is necessary to file two full-length films of each subject. (Though hardly of a conclusive nature, one case of this kind is recorded in Federal Reporter, Volume 122, page 240.) Does the title protect? The printed form of copyright reads as follows:

No.——— LIBRARY OF CONGRESS,
COPYRIGHT OFFICE, WASHINGTON.

To wit: Be it Remembered,

That on the ——— day of ——— anno domini 18— Depue and Jenkins, of Washington, D. C., deposited in this Office the title of a Photograph, the title or



description of which is in the following words, to wit:

"Soap Bubbles"

the right whereof they claim as proprietors in conformity with the laws of the United States respecting Copyrights.

———— ————,

Register of Copyrights.

(The government fee for copyrighting a picture or film is but 50 cents. The office will issue and mail a certificate of the copyright for 50 cents additional.)

If the film is marked "copyrighted" and no copies are filed the copyright is void and a penalty of $25 incurred. If the film is marked "copyrighted" and is not, a penalty of $100 is incurred.

Some have contended that if only a short piece of film is deposited with the title that this short piece might be cut out and the remainder of the film copied. The particular part protected could easily be detected, for that part must bear the stamp, and that part alone. Others have contended that the ribbons are neither photographs, according to the proper interpretation of the law, nor works of art, therefore not proper subjects for copyright. When the writer first called the attention of the Librarian of Congress to this matter (1894) he (the Librarian) positively asserted that these films were not proper subjects of copyright. Later, however, they were admitted for record.

What is needed is a new copyright law, amendments will no longer suffice.

SCIENTIFIC RESEARCH.

The perfection of animated pictures has opened up wonderful possibilities along lines of purely scientific research, and with apparatus now obtainable, susceptible of splendid results, of highly instructive character.

For instance, a number of photographs of a growing plant, made, say, semi-daily or oftener, extending over the entire time covering the complete birth, growth, flowering, fruiting, and decay of the plant, when reproduced on a large canvas by means of the Phantoscope, occur in the space of a very few minutes and reveal to the eye with great vividness the phenomena of growing plants and the retarding or accelerating effect of humidity, pressure, temperature, sunshine, etc. Proper instruments for indicating these conditions of the atmosphere are photographed with the flower or plant studied, producing a record which in the projected pictures are seen simultaneously with the growth of the plant. Two plants growing together, but under varying conditions, say, one by artificial light and warmth and another by sunshine, are photographed and afterward reproduced side by side on the canvas, showing clearly the advantages or disadvantages of artificial propaga-

tion. As object lessons in botany these pictures prove of the keenest interest to the advanced student of science and ought to develop results of public benefit. Motion pictures should be of inestimable value to the medical student, the surgeon, and teacher, for instruction, in recording rare surgical operations, and minimizing pain and cruelty in vivisection.

The same general plan of work has been carried forward under the microscope, the photographs reproduced on the canvas to show the growth of a single petal, for instance. The movement of the blood in the capillary vessels can be shown on the canvas. Motion in the physical world as well as in the world of animated beings is an essential attribute of life, and the growth of animals, birds, microscopical germs, bacteria, microbes, etc., can thus be studied. Possibly there are interesting phenomena of a complex physical nature developing so slowly as to escape our observation under ordinary methods of investigation. Hypothetical deductions produce absurd results on occasions, and science is only exact measurement of observed phenomena. The changes in the human, say the changing animation of a growing baby's face, could be followed and recorded. The clouds in their evershifting forms also prove beautiful and interesting subjects.

The idea is to accelerate the record of very slowly-developing processes until they are easily observed by an entire audience.

Another interesting application is the photographing of the same object, a plant, for instance, every minute between sunrise and sunset, which, when thrown upon the canvas, show the shifting shadows caused by the rapidly-traveling sun from east to the western horizon, as well as the turning of the leaves to face their god all day and bow him out in the evening. The progress of the seasons is also thus shown in the space of but a few minutes, from photographs taken of a tree or a forest. One sees, while comfortably seated in a warm room, the white and barren fields of mid-winter, the melting snows and budding leaves of spring, the waving of the mature foliage of summer, the changing to the browns and reds of autumn, and finally the falling leaves and barrenness of winter again.

Now the reverse, retardation, is just as interesting a subject of study. With a rotating lens camera one is able to take 500 pictures per second with absolute precision, the while giving to each full-timed illumination. This enables one to photograph objects which move too rapidly to be seen or followed by the human eye. For instance, a dragon-fly's wings are photographed and afterward thrown upon the screen so slowly as to be

easily followed and the movements of the wing determined. The rapid changes on the face of the sun and its surrounding chromosphere could also be studied at one's leisure.

Automatic Clock Camera.

In the making of pictures of growing flowers, the recording of cloud formation, the movement of air currents, etc., where the exposures are to be made at regular intervals, a clock in circuit with a motor proves very effective; the clock starts the motor which latter turns the camera once exposing the film and moving the film again for the new exposure. The clock acts as the brains and the motor the muscle of the combination. The clock should be in parallel with the switch on the motor so that the break in the electric circuit is made in the motor circuit and not in the clock circuit, preventing destructive arcing in the clock.

Motion Pictures in Natural Color.

Color photography in motion pictures will be on the market about the time this book issues, and these with stereoscopic effect will produce startling results.

A stalk of corn, say, is photographed through proper color screens day by day or hour by hour from the time it springs from the ground until it withers. These pictures are projected with a special lantern and are viewed by the audience

through binocular eye-pieces. Each onlooker sees upon the screen a green shoot spring up, sees it grow, sees its leaves or blades unfold, sees it put forth tassel and silk, sees it wither and decay, all in the space of two or three minutes. The growing stalk in all its beauty of form and color stands out from the screen, its height and location being as easily ascertained as though one were looking at the actual stalk of corn instead of a picture; surely a veritable realization of the philosopher's dream.

Patent Practice.

It is obviously useless to attempt to set forth patent law or patent practice in the space which can be allowed this subject here, but a few words on the fundamentals might not be amiss. Thus, a patent may be allowed on any new device, method, or composition of matter which has not heretofore been known. The first government fee, paid on the filing of the application, is $15. The complete "application" consists of the application, specifications, oath, and drawings, all of which must be included before the office will receive it. The application is taken up by the office for consideration in the order of its receipt, and in no other way. After the first action by the patent office (which is often a disallowance) the case may be amended until it meets the require-

ments of the office, when, if allowable, the office sends notice to that effect. On payment of the final government fee of $20, which may be any time within six months of the date of allowance, the patent will issue. Reputable registered patent attorneys only may practice before the office. If a patent is worth taking out at all, it is worth the price charged by a good attorney, which, however, does not necessarily mean the highest-priced attorney.

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MOTION-PICTURE LITIGATION.

Motion pictures have not made the advance in America that they have abroad, probably because of litigation, and the threatening letters sent broadcast by claimants. This retarding of so admirable an invention is regrettable, for Yankee genius and energy would doubtless have set the standard of wide introduction far ahead of where it is at this writing if it had been on a sound business basis. However, as the legal atmosphere is clearing very rapid progress will doubtless be now made.

Two principal points were involved in the contentions; *i. e.,* Edison's blanket claim to everything relating to film and cameras, which the Patent Office liberally accepted by issuing patents therefor; and the Jenkins-Armat claim to a projecting machine in which the period of illumination exceeded the period of movement, which was also the subject of a United States patent.

However, the Edison claim to the film was, in March, 1907, disallowed by the courts in the following language:

"Edison was not a pioneer in the large sense of the term, or in the limited sense in which he would have been if he had invented the film. He

was not the inventor of the film. He was not the first inventor of apparatus capable of producing suitable negatives, taken from practically a single point of view, in single-line sequence upon a film like his, and embodying the same general means of rotating drums and shutters for bringing the sensitized surface across the lens and exposing successive portions of it in rapid succession. . . . . Neither was he the first inventor of apparatus for producing suitable negative and embodying means for passing a sensitized surface across a single-lens camera at a high rate of speed and with an intermittent motion, and for exposing successive portions of the surface during periods of rest."

The Jenkins-Armat patent has been the subject of litigation for 11 years already, but, while decisions of lower courts have sustained the patent, the matter has not yet reached final adjudication. Even when it does, if it should be favorable, it will not have the effect on motion-picture business it would have had had it been favorably decided earlier, for while it was necessary to have a more than 50 per cent period of illumination when motion pictures were made on matt film, it is not so vitally essential now because of the improvement in the transparency of the film and the quality of pictures made thereon. Whether the courts will allow an accounting, in case a favorable decision is had, remains to be seen.

FORMULÆ.

DIRECTIONS FOR DEVELOPING NEGATIVE FILM.

Pyro Formula.

Pyrogallic Acid .....½ oz.
Nitrous or Sulphurous Acid..20 minims.
Water .....32 oz.

Sulphite of Soda (Crystals)..... 6 oz.
Carbonate of Soda (Crystals)..... 4 oz.
Water .....32 oz.

To Develop.

Take Pyro Solution, 10 oz.; Soda Solution, 10 oz.; Water, 80 oz.

Restrainer.

Bromide of Potassium .....1 oz.
Water .....6 oz.

Restrainer is to be used only in cases of over-exposure.

As soon as developed rinse in three changes of water and apply a saturated solution of common alum for two minutes, then rinse again and fix.

Fixing Solution.

Hyposulphite Soda .....24 oz.
Water .....96 oz.

After fixing wash thoroughly, then apply for five minutes the

Soaking Solution.

Water .....64 oz.
Glycerine ..... 2 oz.

Use no alcohol in soaking solution.

DIRECTIONS FOR DEVELOPING POSITIVE FILM.

No. 1.

Oxalate of Potash.....10 lbs.
Hot Water .....30 pints.
Acidify with sulphuric or citric acid.
Test with Litmus paper.

No. 2.

Proto-Sulphate of Iron.....2 lbs.
Hot Water .....3 pints.
Sulphuric Acid .....1 dr.
Or Citric Acid .....½ oz.

No. 3.

Bromide Potassium .....1 oz.
Water .....1 quart.

To Develop.

Pour together and add five drams of No. 3.

Mix in the order given. Use cold.

Allow the developer to act until sufficient density is obtained in the shadows; then wash well and fix.

When fixed wash thoroughly.

If there is any tendency to frilling apply a saturated solution of common alum.

Less of No. 2 will give less violent contrasts.

Pyro Developer by Hydrometer Test.

No. 1.

Of a clear Sulphite of Soda solution to test 60 with Hydrometer, take...18 oz.
Pyrogallic Acid ..... 1 oz.
Suphuric Acid .....10 drops.

No. 2.

Sal Soda Solution, Hydrometer test 40.

To Develop.

Take No. 1, 10 oz.; No. 2, 10 oz.; Water, 80 oz.

REMARKS.—More water gives flatness, and less water contrast. Use less water in cold weather.

In summer fix in freshly mixed hypo bath.

Dry quickly. An electric or hydraulic fan is excellent.

Metol-Hydrochinone Developer.

No. 1.

Distilled or pure well water.....32 oz.
Sodium Sulphite (Crystals)..... 4 oz.
Metol .....340 gr.
Hydrochinone .....60 gr.

No. 2.

Water .....32 oz.
Carbonate of Potash ..... 2 oz.

To Develop.

Mix and add an equal amount of water.

By Hydrometer.

No. 1.

Sodium Sulphite Solution to test 30....34 oz.
Metol .....240 gr.
Hydrochinone .....60 gr.

No. 2.

Carbonate of Potash Solution to test 50.

To Develop.

Take No. 1, 20 oz.; No. 2, 10 oz.; Water, 10 oz.

More water gives less contrast and density.

Fixing.

A plain fixing bath, consisting of one part hypo to four parts water, may be used, but it is best then to

immerse the film a few minutes in a saturated solution of alum, and then rinse well and fix. The following chrome-alum fixing bath is recommended:

A.

Water	96 oz.
Hypo	2 lbs.
Sulphite of Soda (Crystals)	4 oz.

B.

Water	32 oz.
Chrome-Alum	2 oz.
Sulphuric Acid	¼ oz.

Pour B into A, while stirring A rapidly. As the chrome-alum dissolves slowly a stock solution of B can be made up.

Depue's Formulæ.

For under exposures:

Metol	1 oz.
Sulphite Soda (Anhydro)	3 oz.
Bi-carbonate Soda	3 oz.
Bromide Potassium	1 dr.
Water	64 oz.

Contrast Developer.

For developing overexposed films:

Water	30 oz.
Sulphite of Soda (Anhydro)	1 oz.
Edinol	100 gr.
Bromide of Potassium	20 gr.
Carbonate of Potassium	½ oz.

This solution can be used repeatedly.

When a film or plate shows overexposure rinse and put in a dish containing the above until sufficiently developed.

Tropical Developer.

Water	100 oz.
Sulphite of Soda (Anhydro))	2 oz.
Bromide of Potassium	40 gr.
Citric Acid	40 gr.

For use.—To the above solution add 250 grains dry Amidol.

Before developing place the film in

Water	60 parts.
Formalin	1 part.

for three minutes, then rinse well and place in the developer.

Fix in the Acid Fixing and Hardening Bath.

Rodinal Developer in Concentrated Solution.

For use.—Dilute 1 part with 20 to 40 parts water for tray development or 1 part with 100 parts for tank development.

Tank Development.

The addition of 100 per cent of water to any of the standard developing solutions makes an excellent tank developing solution.

Metol Developer without Alkali.

Metol without an alkali will develop transparencies absolutely clear in the highlights, and always without fog, in from fifteen to twenty-five minutes to bring out all details.

Intensifier—Mercury.

Prepare a saturated solution of Bichromate of Mercury. Run the film through this repeatedly until it has the proper density. Then pour the solution back into the bottle, as it can be used again and

again until it has lost its strength. Rinse and blacken with a ten per cent solution of Ammonia until the color is entirely through on the back. Wash thoroughly.

Intensifying with Silver.

Prepare the following stock solutions:

Silver Nitrate	¼ oz.
Water	3 oz.
Ammonia Sulphocyanide	½ oz.
Hyposulphite of Soda	½ oz.
Water	2 oz.

To use, add the Ammonia solution to the Silver solution until the precipitate is just redissolved; to each ounce of resultant solution add ½ oz. Pyro stock solution, five minims Ammonia and half a grain of Bromide. In this redevelop until the desired intensity is secured. Immerse in fresh fixing bath for five minutes, and wash. To prevent frilling, first use Alum.

Reducer for Under Exposure and prolonged development.—Immerse in the following:

Water	16 oz.
Ammonium Persulphate	¼ oz.
Sulphuric Acid C. P.	5 drops.

When the intensity is sufficiently reduced, rinse immediately and immerse the negative in

Water	16 oz.
Sulphite of Soda (Anhydrous)	1 oz.

Then wash well.

Reducer for overexposure and overdevelopment.

Dissolve one part Red Prussiate of Potash in fifteen parts water. Use light-proof bottles. Immerse neg-

ative in a Hypo solution (one part Hypo to fifteen parts water) to which has been added a little of the above immediately before use.

ANOTHER METHOD.—Soak the film in Hypo solution and paint with saturated solution Ferricyanide of Potassium in ten parts water.

ANOTHER.—To one part Hypo add one part Ferrous Oxalate and dilute if desired. Flow or paint.

Chromatic Colors.

For Red .....Napthol Red
For Green .....Napthol Green.
For Blue .....Methyl Blue.
For Yellow Screens .....Picric Acid.

Hypo Eliminator.

Use three per cent solution of Bromide of Potassium.

To Remove Pyro Stains.

Hydrochloric, Citric or Oxalic acid added to washing water removes Pyro stains from fingers or clothing.

Silver Stains.

A solution of one part of Iodide of Potassium in twenty parts water is recommended for removing Silver stains from negative or positive films.

Or, 1 oz. Alum, 1 oz. Sulphuric Acid, 3 oz. Sulphate of Iron in 20 oz. of Water. After clearing, wash thoroughly.

Jenkins' Splicing Solution.

Commercial Collodion .....80 parts.
Ether .....20 parts.

Acetone and Amyl Acetate as mending solutions are recommended by some operators.

Formaline and Aluminum Chloride.

A 10 per cent solution of Formaline is coming into use as a hardener for gelatine films; followed by a soaking solution to give flexibility.

Alum or aluminum chloride has the advantage, however, of having no deleterious effect on the operator.

Blue Print Solution.

Citrate of Iron and Ammonia....1⅞ oz.
Water ..... 8 oz.
Ferricyanide of Potassium.....1¼ oz.
Water ..... 8 oz.

Mix equal parts just before use. Paint desired surface with broad brush and hang up in dark to dry.

Blueprints can be toned—

Green by dipping in
Water .....10 oz.
Sulphuric Acid .....15 minims.

Violet by dipping in
Water .....25 parts.
Acetate of Lead.....1 part.

Sepia by immersing in
Water .....10 oz.
Tannic acid .....1 dr.

then into
Water .....4 oz.
Carbonate of Soda .....1 dr.

then again in the Tannin bath.
Repeat as often as required.

Sepia prints can be copied.

Paper Sensitive to Light.

Commercial papers sensitive to light are obtainable at any stock house. Bichromatized paper, without

pigment, is made by flowing with 10 per cent gelatine, and after drying sensitized with 10 per cent solution Bichromate of Potash or Ammonia. Dry in the dark.

Paper Sensitive to Heat.

Bichromatized paper (without pigment) should be dipped, after exposure and development, in a very dilute solution of Sulphuric Acid, say, fifty drops in one oz. of water. When dry it is colorless, but heat brings out the image very black.

Paper Sensitive to Moisture.

Bichromatized paper (without pigment) should be dipped, after exposure and development, in a 10 per cent solution of Chloride of Cobalt. In damp weather the image is scarcely visible, but in dry weather it is a bright blue.

Paper Sensitive to Electricity.

Saturate paper with the following solution:

Nitrate of Ammonia	3 oz.
Muriate of Ammonia	1½ oz.
Ferro-cyanide of Potassium	¼ oz.
Water (fluid ounces)	16 oz.

The presence of iron through which a current of electricity is passing will cause that part of the paper or image to turn blue.

Water Pictures.

Bichromatized paper (without pigment) dipped, after exposure and development, in a solution of Sulphurous Acid will bleach. Let it dry and no image appears. Immersing in water will again bring out the image.

To Preserve Labels.

Paint the label with bees' wax and rosin, equal parts, hot. Hot parafine will answer, but not so well.

An Adhesive for Cloth to Metal.

Tragachauth	1 oz.
Gum	4 oz.
Water	15 oz.

Shellac will also attach cloth, leather, or wood to metal.

Waterproof Cement.

Bichromate of Potash	8 parts.
Gelatine Size	11 parts.
Alum	1 part.

Retouching Varnish.

To Sandarac, add 2 oz. Alcohol to cut and make the right thinness. To 16 oz. add 1 oz. Oil of Lavender to toughen.

Ground-Glass Solution.

The following solution, poured over a glass plate, set level, and allowed to dry spontaneously (not in a draft of air), will produce a fine matt surface. The proportion of benzole determines the nature of the matt obtained.

Gum Sandarac	1 oz.
Gum Mastic	¼ oz.
Ether	10 oz.
Benzole	5 to 15 oz.

Photographing the Invisible.

Bisulphate of Quinine solutions, or drawings, tracings, or paintings thereof, are invisible to the eye but are photographically visible, and the application of

this knowledge is used by the unscrupulous in one form of " spirit photographs."

Chemically Coloring Colorless Solutions.

In thin glasses place weak solutions of (1) ferrocyanide of potassium; (2) sulphocyanide of potassium; (3) bichromate of potassium; (4) ammonia; (5) ammonium sulphate; and sulphuric acid. Into each of these pour very small quantities of lead nitrate dissolved in water. All were clear solutions, but this will produce, respectively, blue, red, brown, black, and white solutions.

Perchloride of iron can also be used for the colorless coloring solution, and the strength of the solutions will also vary the colors from one to the other end of the spectrum.

Remember these are poisons.

Dead Black Varnish.

Lamp Black	½ oz.
Liquid Shellac	1 oz.
Alcohol	10 oz.

To Blacken Brass.

No. 1.

Nitrate of Silver	¼ oz.
Nitrate of Copper	¼ oz.
Water	2 oz.

Clean the brass thoroughly and dip for a moment only. Let dry and then heat in flame.

No. 2.

To one gallon muriatic acid, add good, soft iron to saturation; then add half pound yellow arsenic. Let this age for three weeks (the older it gets the better). Dip the work, then wash and dry; then dip

again, and wash and dry. Then lacquer, preferably with blue lacquer.

Steel Blue on Brass.

Steel blue color on brass or copper is obtained by dipping the piece in a solution of

Potassium Sulphide .....½ oz.
Common Salt .....½ oz.
Water .....8 qts.

Iridescent Surface on Brass.

Dip work in the following solution, and then wash and dry:

Acetate of Lead ..... 1 part.
Hyposulphite of Sodium ..... 8 parts.
Water .....48 parts.

To Make a Flexible Screen.

Mix boiling water and whiting until the mixture is of a creamy consistency. To one gallon of this mixture add one pint of fluid glue and one pint of glycerine. Paint on the stretched canvas with a wide brush and lay it on smoothly. When dry this canvas can be rolled.

To Soften Hardening Rubber.

Rubber bulbs, etc., which have begun to harden will often soften if immersed for a time in turpentine.

To Drill Glass.

First, dip a white-hot drill into quicksilver to make it very hard. Then sharpen on a fine carborundum or other stone. With this drill, kept moistened frequently with a saturated solution of camphor and oil-of-turpentine, glass may be drilled almost as rapidly as metal.

For Burns.

Apply wet bi-carbonate of soda (common cooking soda). It will "take out the fire" almost at once.

Fireproofing Solutions.

A saturated solution of phosphate of ammonia is excellent for fireproofing fabrics of all kinds, or wood or other porous substances.

A saturated solution of sulphate of aluminum is also a very cheap and efficient fireproofing substance

Fire Grenades.

Put the following solution in thin glass bottles, which may be easily broken by throwing them into or near the base of a fire. The bottles should be well corked and stored upside down to prevent evaporation.

Common Salt	2 lbs.
Ammonium Chloride	10 lbs.
Water	3 qts.

Fire-Extinguisher Dry Powder.

Bicarbonate of Soda	40 parts.
Sal Ammoniac	25 parts.
Whiting	35 parts.

WEIGHTS AND MEASURES.

4 gills	1 pint.
2 pints	1 quart.
4 quarts	1 gallon.

1 pint	28.875 cu. in.
1 quart	57.75 cu. in.
1 gallon	231.00 cu. in.

Apothecaries.

1 pound	.....	12 ounces.
1 ounce	.....	8 drams.
1 dram	.....	3 scruples.
1 scruple	.....	20 grains.

Avoirdupois.

1 pound	.....	16 ounces.
1 ounce	.....	16 drams.
1 dram	.....	27.34 grains.

Fluids.

1 pint	.....	16 ounces.
1 ounce	.....	8 drams.
1 dram	.....	60 minims.

Chemicals are sold by Avoirdupois weight.

Metric Measures and Weights.

Millilitre	.001	Milligramme ...	.001
Centilitre	.01	Centigramme ..	.01
Decilitre	.1	Decigramme ...	.1
Litre	1	Gramme	1
Decalitre	10	Decagramme ..	10
Hectolitre	100	Hectogramme ..	100
Kilolitre	1000	Kilogramme ...	1000
Myrialitre	10000	Myriogramme ..	10000

Conversions.

Cubic Centimetre = .061 cubic inches.
Millilitre = Cubic Centimetre = .00845 gill.
Litre = Cubic Decimetre = 1.057 quart.
Milligramme = .015 grains.
Gramme = 15.432 grains.
A 5-cent nickel piece weighs exactly 5 grammes.
Kilogramme = 2.2046 pounds.

Millimetre = .04 inch, *i. e.*, 1/25 inch.
Centimetre = ⅜ inch.
Metre = 39.37 feet = 3 feet 3⅜ inches.
Kilometre = .6214 miles.
Litre = 61.025 cubic inches.
Hectolitre = 3.532 cubic feet.
Litre = 2.198 pounds of distilled water.
Gill = 7.2187 cubic inches.
Pint = 1.07 pounds of distilled water.
Quart = 2.15 pounds distilled water.
Gallon = 231 cubic inches = 8.322 pounds of distilled water.
1 litre = 1000 cubic centimetres = 33.83 fluid ounces.
1 cubic centimetre (c. c.) = 17 minims.
1 ounce Avoirdupois = 437½ grains = 28.35 grammes.
1 ounce Troy = 480 grains = 31.10 grammes.
1 kilogramme (kilo) = 1000 grammes = 35.27 ounces Avoirdupois.
1 gallon = 3785 cubic centimetres.
1 quart = 946 cubic centimetres.
1 pint = 16 fluid ounces = 473 cubic centimetres.
1 fluid ounce = 8 drams = 29.574 cubic centimetres.
1 dram = 60 minims = 3.697 cubic centimetres.

1 cu. cent. .....1 gramme.
1 kilogramme .....1 litre.
1 dram .....60 grains.
1 gramme .....16.5 minims.
1 dram .....4 cu. cent.
1 gramme .....15.5 grains.
1 litre .....34 ounces.
1 dram .....4 grammes.
1 grain .....065 gramme.
1 gramme .....15.4 grains.

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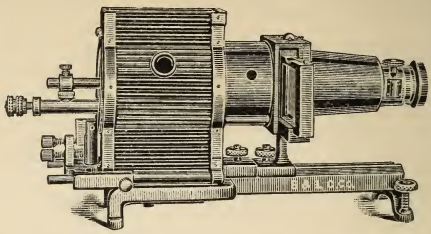

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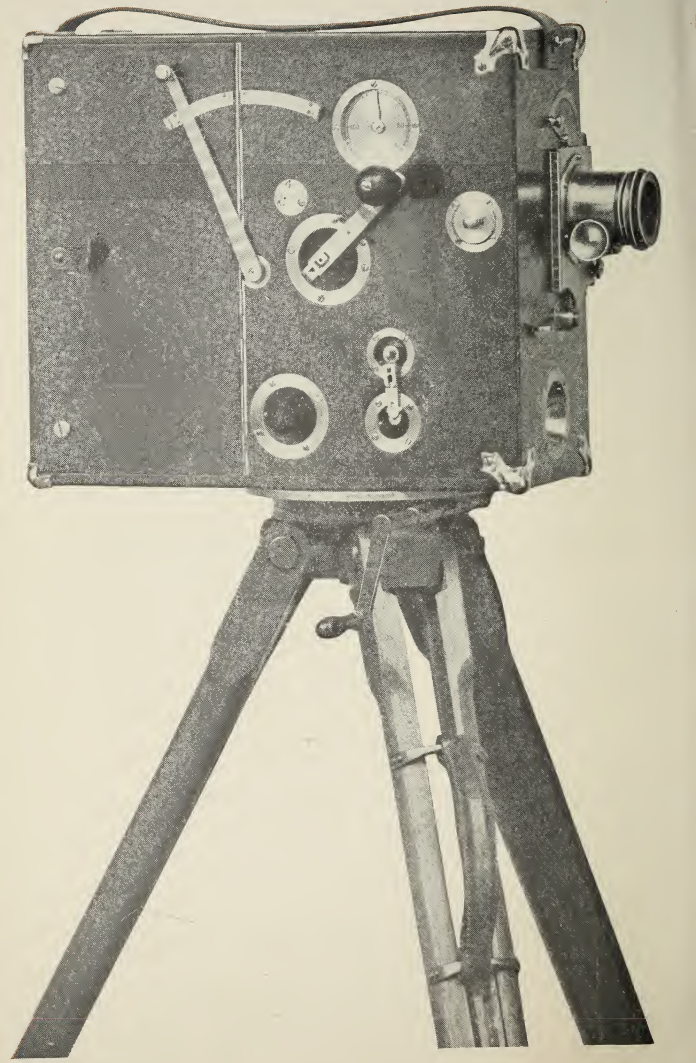

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It has a set of two interchanging lenses of different foci; a rising and falling front; a perfectly balanced focal-plane shutter, the opening in which can be increased or diminished while the machine is in motion; six detachable light-tight film boxes, each of 200 feet capacity; indicator showing the amount of film used at any moment; a level, and a constant-view finder; window masks of any size or shapes desired; a main crank which folds inward and out of the way without being detached; and an auxiliary folding trick-picture crank which makes but one picture each revolution and gives uniform exposures no matter how slow or how fast the crank is turned. The lens when all the way back is in universal focus. A tripod nut is provided in the top of the camera so that reversed pictures may be made directly in the camera. A solid leather carrying case is provided.

The tripod has a permanently-fixed panorama head; a removable rocking head; stiff telescoping non-folding legs; and is fitted with protecting caps at each end, and a handle for convenient carrying.

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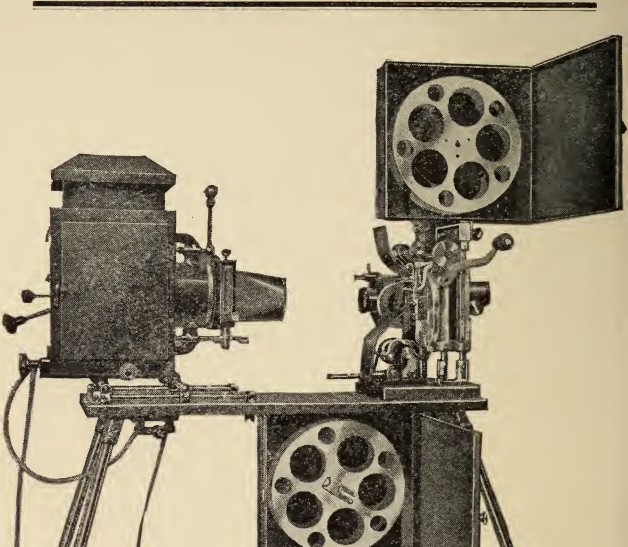

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¶ The machine must run smoothly and quietly.

¶ The film reels must be enclosed in fireproof magazines provided with film valves through which fire cannot travel, and which do not injure the film in the slightest degree.

¶ The lamp house must be large and roomy and should have a mica-lined top to prevent short circuits through contact of the upper carbon with the top of the lamp house.

¶ Film shields must be provided to protect the loops of film above and below the "mechanism" or "head" of the machine.

¶ An automatic shutter must be provided to cut off the light from the film the instant the motion of the film ceases.

¶ The rheostat must be so enclosed that it cannot set fire to inflammable materials coming in contact with it.

¶ The machine must be durable and must be so constructed that it will not injure the film.

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